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Information Technology Division

REPORT
ERL-0689-RE

THE OPERATIONAL MOVEMENT PLANNING SYSTEM: A PROTOTYPE FOR THE STRATEGIC COMMAND FUNCTION

by

J. Clothier, M. Carthigaser and J. O'Neill

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The Operational Movements Planning System: A Prototype for the Strategic Command Function (U)

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Malathi Carthigaser, Jennie Clothier & John O'Neill

SUMMARY (U)

This paper describes the Operational Movements Planning System (OMPS); a prototype computer system to support the Defence Movements Co-ordination Agency in planning strategic movements. OMPS consists of two elements. The Staff Table Manipulation Tool stores, retrieves, sorts and summarises staff table information. The Planning Process Software supports the definition, storage and application of constraints, and multiple methods for the allocation of items to be moved to transport assets.

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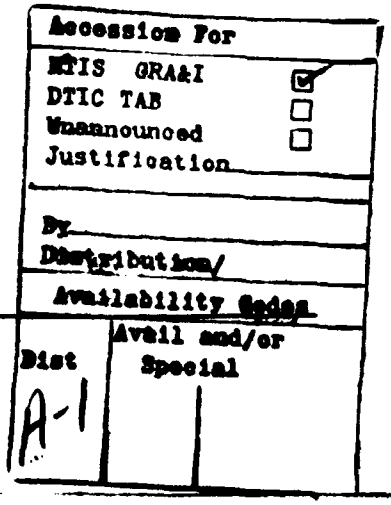
Postal Address: Director, Electronics Research Laboratory, PO Box 1500, Salisbury, South Australia, 5108.



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LIST OF ABBREVIATIONS

ACOPS	Assistant Chief of Staff for Operations
ADF	Australian Defence Force
CORE	Controlled Requirements Expression
DGJMOVT	Director General Joint Movements and Transport
DMCA	Defence Movements Coordination Agency
DSTO	Defence Science and Technology Organisation
ERL	Electronics Research Laboratory
HQADF	Headquarters of the Australian Defence Force
MPSS	Movement Planning Support System
OMPS	Operational Movements Planning System
ORBAT	Order of Battle
PPS	Planning Process Software
STMT	Staff Table Manipulation Tool

1 BACKGROUND

1.1 Task objectives

Under the sponsorship of the Director General Joint Movements and Transport (DGJMOVT), the DSTO was tasked with defining the user requirements for an Operational Movements Planning System (OMPS) to support the Defence Movements Co-ordination Agency (DMCA).

1.2 Overall approach

Prior to the tasking of the DSTO, several studies had attempted to define the requirements for an OMPS. When completed, these studies were felt by potential users to have not captured their requirements. Most of these preceding studies had used extensive interviewing and questionnaires as the basis for requirements capture.

The work of the DMCA is complex and demanding. They are often asked to plan with uncertain and constantly changing information. To overcome these problems they must use expertise and knowledge which may have been acquired over many years.

Due to the failure of previous studies and the complex nature of the DMCA's work, it was thought a prototyping approach would be the most appropriate method for requirements capture. The prototyping approach taken was one which attempted at all times to integrate the future users into the prototyping team. Great emphasis was placed upon the user interface as this captured how the future user would perceive the final system.

1.3 Task execution

The OMPS prototype for the DMCA has been completed by a three person team over an eighteen month period. Four basic methods have been used to complete the study.

A detailed task analysis identified the role and work undertaken by the DMCA in terms of the information and knowledge required to perform strategic movements planning.

Storyboards (a series of user interface screen pictures depicting a scenario) were designed and implemented for tasks considered suitable for automation or co-operative computer support.

Functions to support the user interface features and behaviours were prototyped using commercial off the shelf products and programming languages.

CORE (COntrolled Requirements Expression), a method for managing the specification of requirements, was applied to define high level data flows.

Execution of the OMPS prototyping task has required an evolutionary prototyping approach. How this was achieved is discussed in detail in ERL - 0690 - RE.

2 INTRODUCTION

2.1 Command support system development in the ADF

In the 1987 Defence White Paper, command and control is viewed as a priority capability for force development. Australia has unique command and control requirements. The nation's unique intelligence, surveillance and sensor needs require Australia to procure command and control systems tailored to our specific environment. The White Paper identifies "computer based systems to support the decision making of operational and higher level commanders" as an important capability to be developed for the Australian Defence Force (ADF) in the years to come.

The development of a command support system for the Headquarters of the Australian Defence Force (HQADF) and other operational headquarters is currently being planned by the ADF Joint Command Support Environment Project. A basic command support system will provide electronic battlemap capabilities with database support, office automation capabilities and automated messaging. Tailored support to the many specialist areas in HQADF cannot proceed until more is known about the requirements of these functions.

2.2 Specialist command functions in HQADF

Excluding the Command function itself, twelve other specialist areas may be called upon within HQADF. The twelve areas are: operations, plans, intelligence, electronic warfare, communications, logistics, movements, administration, engineering and medical, legal, public relations, and single service liaison officers.

Each specialist area supports the Assistant Chief of Staff for Operations (ACOPS) in providing advice, preparing planning options, executing missions and monitoring specialist operations.

2.3 The movements function in HQADF

The Defence Movements Co-ordination Agency is responsible for providing strategic movements planning advice to the operational planners within HQADF.

Currently little specialist computing software exists to support the DMCA. The Movement Planning Support System (MPSS), built by Central Studies Establishment in the early 80's, matches transport assets to terminal facilities. The process occurs on an individual transport asset basis, and is unable to address groups of transport assets. The DMCA seldom use MPSS as it does not integrate well into their problem solving process or support software.

2.4 Why prototype the movements function?

Traditionally computer support has been targetted at tactical areas of an organisation where standard operating procedures exist and objective decisions can be made. When extending the application of computers into the upper levels of an organisation higher productivity gains may be made if more objective tasks are tackled first. The reason for this being that objective tasks can be more easily stuctured for computer support than subjective tasks.

It can be argued that logistics and movements are the most information management oriented and objective of the command functional areas. For these reasons, the DMCA's work was seen as one of the most amenable to early computer support within HQADF.

3 THE MOVEMENTS PROBLEM

3.1 Overview

The DMCA is responsible for the preparation, implementation and monitoring of ADF movements plans and instructions for movements into, out of and between areas of operations for joint operations, major exercises and national emergencies.

Strategic movements planning is most often initiated by the strategic operations planners within HQADF. The DMCA provide advice on how best the force may be moved for an operation. Usually DMCA receives a Concept of Operations stating in broad terms the mission, limitations on achieving the mission and the Order of Battle (ORBAT).

The DMCA seeks or receives information from all deployable military units on their current complement in terms of personnel and equipment. This information is then collated for deploying units to derive a total bill.

To plan a movement the DMCA must liaise with the mode operators who will perform the operational element of the movements plan.

Planning movements must also be done in co-operation with the operational level operations planners. This ensures that movements are made to the most operationally appropriate points of entry into the area of operations.

3.2 Planning questions

The information required for movements planning is sourced from seven questions:

(i) What is to be moved?

(ii) Where is it to move from?

(iii) Where is it to go to?

(iv) When is it available to move?

(v) When must it arrive?

(vi) What is available to move it?

(vii) What limitations are there?

When complete and certain answers can be found to all these questions the process of movement planning can occur. Under these circumstances the planner would perform staff checks, an appreciation, develop an outline plan and then prepare a movement instruction in chronological order, never having to backtrack or revise.

In practice, rarely does the planner have all the information required for an operation. More often than not, movement requirements change in terms of what is to be moved and what is available becomes unavailable. The full restrictions on the move may only become apparent as time evolves.

3.3 Modes of operation

It is unusual for the DMCA to be given a complete requirement for a mission. A complete requirement would state exactly which units are to move when and to where, using transport assets that are known to be available.

An OPCAT may not always state which units are to be moved, but only the type of unit. Under these circumstances the most appropriate available unit has to be selected or possibly created.

Occasionally, the DMCA is told which transport assets will be made available, but it is more usual for the DMCA to have to derive which transport assets are most suitable and then determine if these assets can be made available. These derivations are made on past experience of what is likely to be made available and any new factors that may alter the suitability.

The routes to be taken, the facilities to be used, changes in mode required and possible loads for transport asset types all have to be considered during the strategic planning process.

3.4 Deriving a plan

How a strategic movements plan is developed depends very much upon the information given and the constraints imposed upon the DMCA.

During the development of the OMPS prototype a great deal of effort was expended in trying to capture planning as a process. Eventually, eight key steps were identified as shown in Figure 1.

3.4.1 Determine what is to move by location by destination

In its most straightforward form, this step simply collates the staff tables (staff tables quantify the current complement of a unit in terms of personnel, equipment and stores) for units which have a common location and destination. Should a specific unit not have been stated, or should there be the need to derive a unit with a special function, then this step is more complex. It may require the user to search for suitable units. This obviously needs an extensive knowledge of the make up and nomenclature of military units comprising the ADF and each units ability to be fragmented.

Once all the units have been identified, the items (personnel and equipment) held by the units may be collated in a total bill for the move. This states how much has to be moved for each staff table category. A total bill is useful in that it gives a feel for the overall size of the move and highlights any category that is particularly large.

3.4.2 Determine what is to move by location by destination by time

A timeframe window may be added to each unit moving from the same location to the same destination. The timeframe may be expressed as Earliest Departure Date, Latest Departure Date, Earliest Arrival Date or Latest Arrival Date. Usually the Unit supplies the Earliest Departure Date, and the Operations Staff the Latest Arrival Date.

Dates may be given in various forms. They may be actual dates, but this is unusual in strategic planning. Often a nominal D-day (the day the operation is to start) is established and all other times are given in relation to D-day. Units may not express an Earliest Departure Date, rather a notice to move period will be stated in terms of D-days.

At the end of this step, the units to be moved from the same location to the same destination in the same time period are collated.

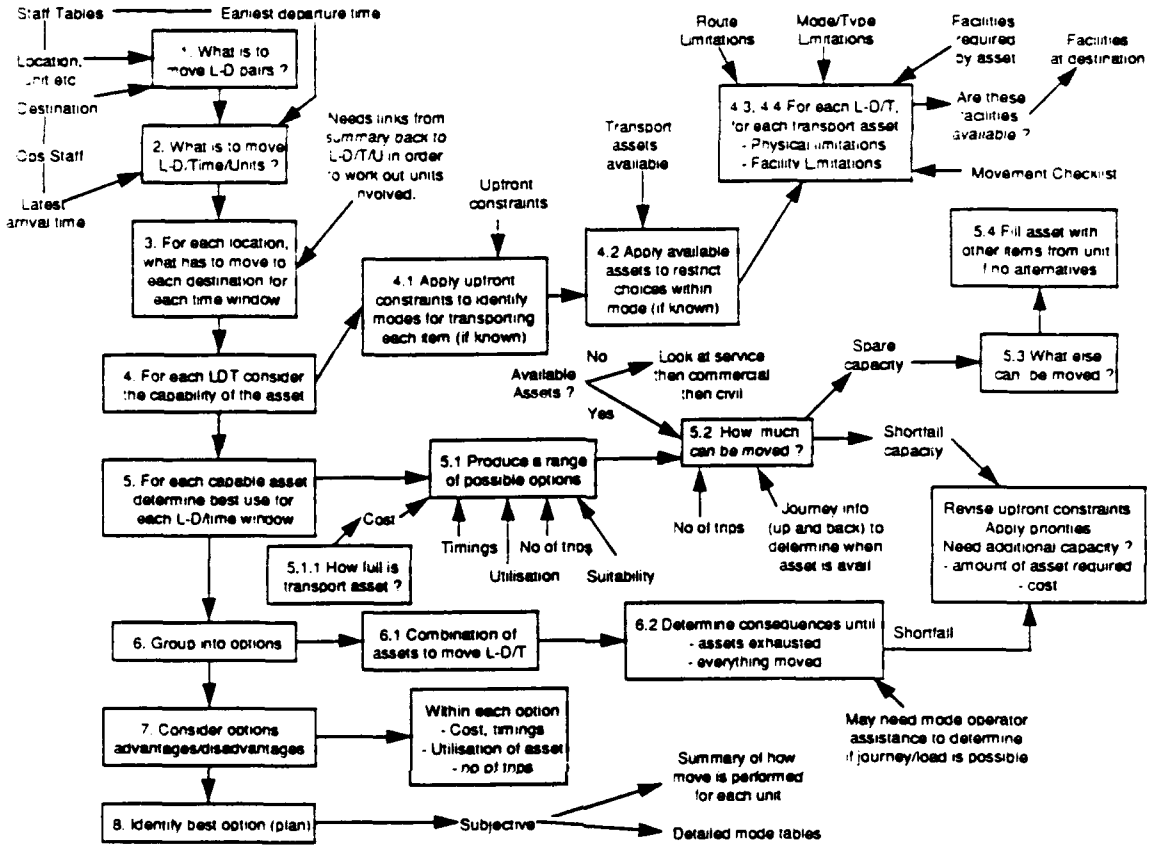


Figure 1. The planning process supported by OMPS

3.4.3 Summarise items to be moved

Previous steps have expressed what is to move in terms of the unit. The third step looks at what has to be moved in terms of the items held by each unit contributing to a group having the same location, destination and timeframe. Summarising in terms of the items gives a total bill for the location, destination and time criteria. At this stage it is also important to maintain what items belong to what unit, as unit integrity can be very important when allocating items to transport assets.

3.4.4 Consider capabilities of the transport assets

In this step, the capable transport assets for each item summary are identified. Determining capability is a very complex process. Capability requires that the transport asset is available and does not violate any, of what may be several, operational constraints.

(a) Apply upfront constraints. Upfront constraints are applied to each item summary to determine the most favoured modes or to rule out the use of certain modes. For example, should the move be overseas, road and rail transport will not be considered and air transport may be used, wherever possible, to move personnel.

(b) Apply available assets. The planner determines whether a transport asset is avail assumes it will be available. In essence what this does is to restrict the number of p transport asset choices within a capable mode.

(c) Apply operational limitations. Operational limitations fall in to three broad cate physical, journey and facilities. At this point in the planning process the question asked is: Is there a relationship between the transport asset and the facility, item journey which would prevent the transport asset from being used?

Physical limitations can have simple yes/no answers, such as, can a B737 transpor tonne tracked vehicle? There may be the odd exception to the rule but in general the F planner knows what items can and cannot be transported by a transport asset.

Journey limitations look at such things as road capacity or flight corridor limitation example, road trains are not permitted east of Bourke in New South Wales. At Bourke trains are broken up into semi-trailers no larger than two units.

Facilities limitations are extensive and address the operational and handling capabilit ports, airfields, railheads and road stages. Some facilities limitations veto the u particular transport asset types, or combinations of modes. They limit the numb transport assets that can use the facility at any one time. The ability to unload and trar an item from the facility is also considered.

3.4.5 *Determine 'best' use of capable assets*

For each item summary, determine the best use of the capable assets. Again this is a comple which may require several iterations.

(a) Produce a range of possible options. Determining the 'best' use of capable tran assets requires the planner to produce a range of options as to how the items m moved from the location to the destination.

Producing a range of options entails assessing how full a group of capable transport a are, what is the cost associated with the loads designed, how many trips will be req and how do the timings of the trips relate to other aspects of the plan. Two qualities w emerge during this process are utilisation and suitability.

Utilisation relates to how full a transport asset is and how efficiently the trip schedul the transport asset is designed.

Suitability addresses whether or not the items are using the transport assets best equi to take them.

(b) Determine how much can be moved. Determining how much can be moved by transport assets that are available (or assumed available) and do not violate any o operational limitations, requires the planner to address the number of possible trips may be made by a loaded transport asset.

It should be remembered that at this point the planner has taken into consideration h transport asset is to be loaded. In determining transport asset availability, the pla usually looks at what is known to be the 'best' transport asset for the sets of items t moved.

Where a transport asset has spare capacity, poor use of other assets is considered and the difference minimised. If there are no alternatives, a transport asset is filled with other items from the same unit or units.

If all the items cannot be moved by the available transport assets, the planner may make several changes. Upfront constraints could be relaxed and suitabilities revised. Priorities could be applied to certain sets of items. Additional capacity could be made available by the use of more transport assets but the cost implications of this action must be resolved.

3.4.6 Group into options

Grouping the 'best used' capable assets to move items from a location to a destination in a given timeframe generates options for the move.

(a) Combine transport assets to move items from location to destination. Items to be moved from a location to a destination within a timeframe may have widely varying transport requirements. Different transport asset types or even modes may be necessary.

When combining transport assets there is the need to consider other sets of items which may be moved from a location to a destination in a timeframe which is a subset of the main requirement due to the route being taken.

(b) Determine consequences. When combining the use of transport assets to move sets of items within a timeframe, the consequences should be recorded. Consequences determine if further use of the asset is possible, if the plan is complete and act as important determinants of the advantages and disadvantages of the option.

3.4.7 Consider advantages and disadvantages of options

Each option is considered in turn to determine its advantages and disadvantages. The criteria for determining an option's advantages and disadvantages are very similar to those used to derive the 'best' use of assets although the qualities now belong to the overall plan as opposed to elements of the plan. Options are assessed according to cost, timings and utilisation.

3.4.8 Decide 'best' option

A decision is made as to which plan option is the most suitable. This decision can be quite subjective as the qualities a plan must hold may not be summarised within objective categories such as cost, timings and utilisation.

Once a plan option has been chosen and approved, the movement instruction is prepared. There are two distinct components of the movement instruction. The first element is essentially the movement concept in standard format. The second element is the detailed movement tables stating, by mode, how and when items are to be moved from their location to destination.

3.5 Plan qualities

The movement instruction prepared by the DMCA encapsulates a plan which must support the main operation and provide guidance to the operational planners. The qualities required of a successful strategic plan are difficult to capture.

Tactical plans capture relatively simple procedures or processes that are to be executed soon. There is very little uncertainty in the information used to derive the plan. Tactical plans are often repeated with little change and may be subjected to optimisation or continuous process improvement.

Strategic plans are rarely repeated and the information used to derive the plan is often incomplete, uncertain and changing over time. Under these circumstances it is very difficult to be confident that the plan produced is 'optimal' or to be able to introduce continuous process improvement.

A plan produced by the DMCA must bear at least the following features:

(i) Feasibility which can be quickly perceived;

(ii) Operational soundness in order to support the operations plan;

(iii) Financial soundness in that it is cost effective and has demonstrable cost benefits;

(iv) Guidance with flexibility to provide a framework for operational movement planning which does not over constrain subordinate planners and permits process improvements to be made;

(v) Flexibility to permit strategic plan repair.

4 THE OMPS PROTOTYPE

4.1 Overview

The OMPS prototype provides computer support to the planning process outlined in Section 3. It does not attempt to completely automate the planning process. Our approach was to automate relatively simple tasks where information was sufficiently complete, and to integrate this automation into an environment which supports definition, partial application and tracking of planning information for the user. The underlying design theme was empowerment of the user. Task management and ultimate control always rests with the user.

OMPS does not force the user to execute the planning process in any particular order. OMPS attempts to reflect how the user solves the problem. Small parts of the problem may be completely or partially solved as the necessary information becomes available.

OMPS allows the user to define preferences and constraints whether these be of an operational or personal nature. It enables the user to solve the planning problem from multiple perspectives. A perspective can be in terms of the level of detail or aspect of the domain. For example, the allocation process within OMPS allows the user to allocate in respect to transport assets, items or units, either at a summary or individual level.

The OMPS prototype consists of two distinct elements: the Staff Table Manipulation Tool (STMT) and the Planning Process Software (PPS). The STMT stores and collates the staff table information for an operation acting as a pre-processor of information for the PPS. The PPS supports the user in defining and applying limitations and preferences. It also executes some planning procedures and tracks the allocation of assets to items.

4.2 The Staff Table Manipulation Tool

During the analysis of the work undertaken by the DMCA, it became apparent that before any planning work could proceed the planners had to decide what was to move and to sort the staff tables for the units moving. Initially, this task was thought to be quite small and straightforward. However, it was soon realised the movement planners represent units and staff tables in a variety of ways. This activity can amount to a complex task with a significant workload.

4.2.1 The relationship between units and staff tables

The STMT allows the user to manipulate a variety of staff table types whose existence depends upon the problem being solved at the time.

The STMT recognises four types of staff tables: Permanent, Generic, Composite and Unit. Staff tables are derived from units which may exist in several forms.

A **Permanent Unit** is an existing deployable unit.

A **Generic Unit** is a theoretical unit that does not exist.

An **Operational Unit** is a unit on the ORBAT which consists of elements (an element is a component of a unit) belonging to the same permanent unit.

A **Composite Unit** is a unit on the ORBAT which consists of elements belonging to different permanent units.

A **Permanent Staff Table** is a staff table which records the data related to a **Permanent Unit.**

A **Generic Staff Table** is a staff table which contains the entries expected of a unit if formed.

A **Composite Staff Table** is a staff table which records data related to a composite unit or a composite unit identified by unit and destination.

A **Unit Staff Table** is a staff table which records data related to an operational unit or pa operational unit identified by unit, split part (see definition below) and destination.

A **Split Part** is related to an Operational Unit and Unit Staff Tables. It is where elements ha separated from the rest of a unit and have been given a unique identifier.

Figure 2 illustrates the staff table types and how they relate to the different units that ma The diagram shows one possible sequence of events which demonstrates the way unit staf are formed. Unit staff tables are identified by a unit name, split part and destination. For el of operational units recently added to the ORBAT, the unit name, split part (= unit name) a destination (initially unknown) will all be the same. The operational unit at this point in tir have only one unit staff table associated with it, in this case identified by unit name = pu part = pu1 and destination = UNKNOWN.

If some elements (p11, p12) of this unit (pu1) are later separated from the main unit to form part (sp1) then two unit staff tables will result. The first one is identified by the unit name split part =sp1 and destination = UNKNOWN, while the remaining element (p13) of the ma (pu1) still occupies one staff table, identified as before.

Assigning known destinations to elements also causes changes in the number of staff maintained. For instance, if one element (p11) is assigned a destination (d1) and the other e (p12) is assigned another destination (d2), two unit staff tables result. The first is identified unit name = pu1, split part = sp1 and destination d1, while the other is recognised by th name = pu1, split part = sp1 and the destination = d2.

It should be noted that in reality, the actions of forming split parts and setting destinatior take place in any order.

Composite staff stables are identified by the unit's name, as well as destination. When composite unit is formed, it has only one staff table associated with it, identified in this case unit name = cu1 and destination = UNKNOWN. As the destinations become known ar entered, the number of staff tables starts to multiply. For example, if one element, p1 destination d1 and the element p24 has destination d2, there will be two composite staff The first will be identified by the unit name = cu1, destination = d1 and the other by the unit = cu1 and destination d2, as shown in the diagram.

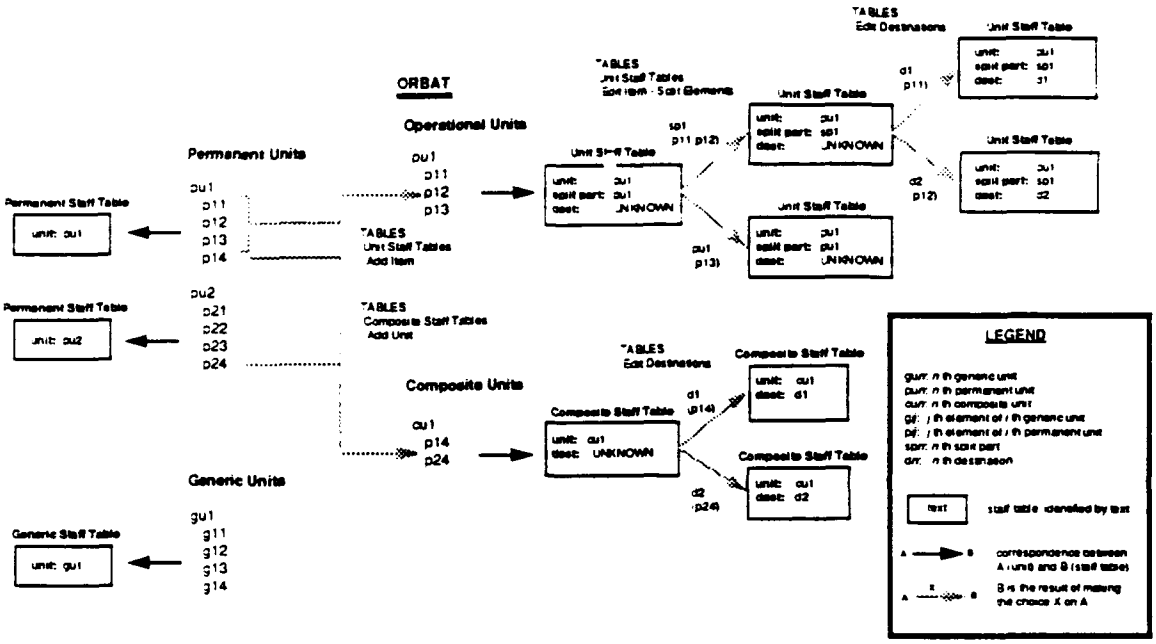


Figure 2. The relationship between units and staff tables

4.2.2 Tasks performed

The STMT has four basic functions:

(i) Storage of generic and permanent staff tables;

(ii) Generation of operational tables such as unit and composite staff tables;

(iii) Retrieval of staff table details according to various criteria eg table type, service, location, time.

(iv) Summarising staff tables according to selected criteria.

Figure 3 shows the menu options available under the storage function. Generic and permanent staff tables may be added to and deleted from the database. Entries in the database may also be edited.

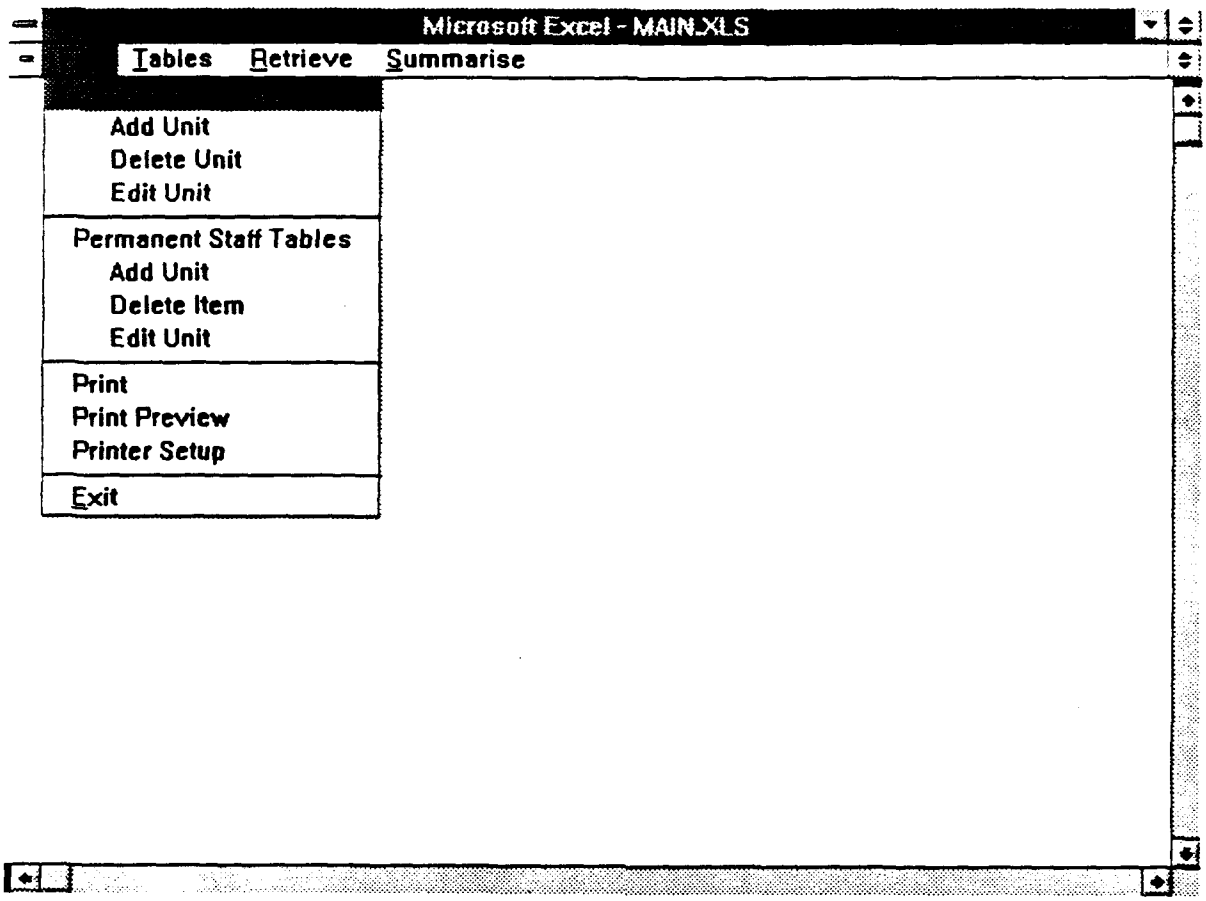
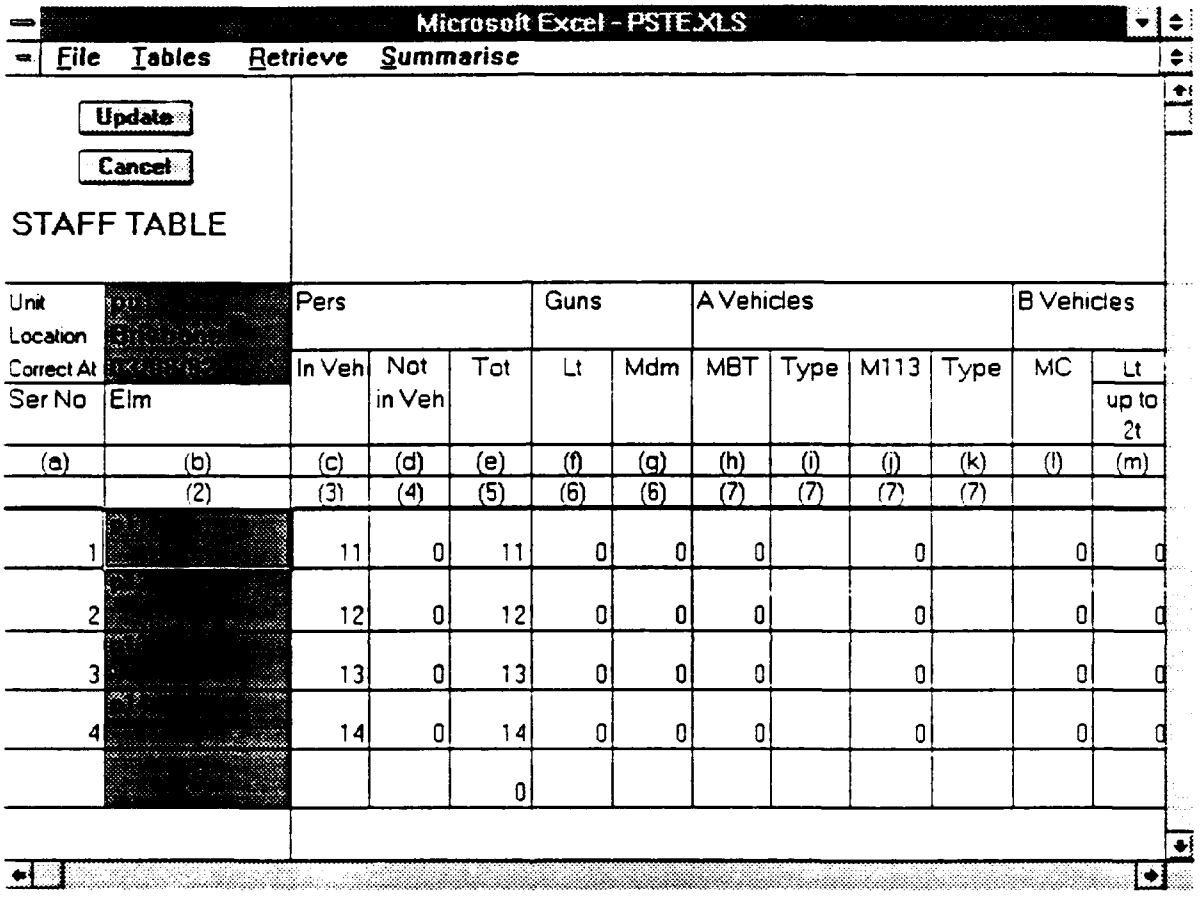


Figure 3. Storage options for permanent and generic staff tables

Addition and editing of staff tables is via a simple to use interface (see Figure 4) which accurately depicts the current paper-based format for staff tables. All staff table information is stored without the user having to know that there is an underlying database or how the particular database operates.



Unit		Pers			Guns		A Vehicles				B Vehicles	
Location												
Correct At		In Veh	Not in Veh	Tot	Lt	Mdm	MBT	Type	M113	Type	MC	Lt up to 2t
Ser No	Elm											
(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	(m)
	(2)	(3)	(4)	(5)	(6)	(6)	(7)	(7)	(7)	(7)		
1		11	0	11	0	0	0		0		0	0
2		12	0	12	0	0	0		0		0	0
3		13	0	13	0	0	0		0		0	0
4		14	0	14	0	0	0		0		0	0
				0								

Figure 4. Staff table representation within the STMT

Generating the operational tables is performed under the Tables (see Figure 5) menu item of the STMT. Unit staff tables and composite staff tables are generated by the addition, deletion and editing of items and units respectively. In the context of the STMT an item is the general term for a unit or element.

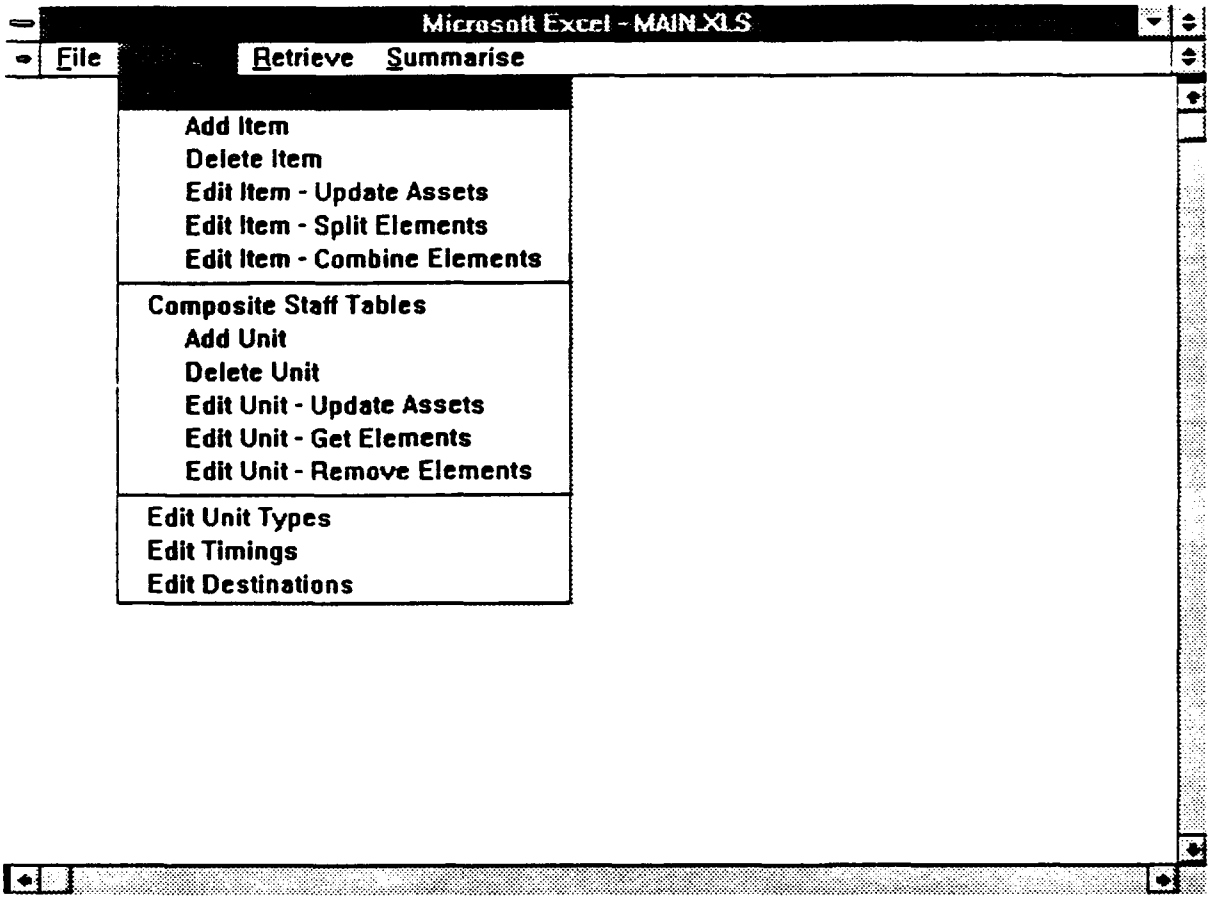


Figure 5. Menu options for generating operational tables

Under this option the user can also add other operational information to the tables. The type of the unit may need to be edited to reflect its role in the operation. If known, the destination of a unit may be added at this time. Should timing information be available then this can be associated with the appropriate staff table. Figure 6 shows the various formats in which time may be represented in the STMT.

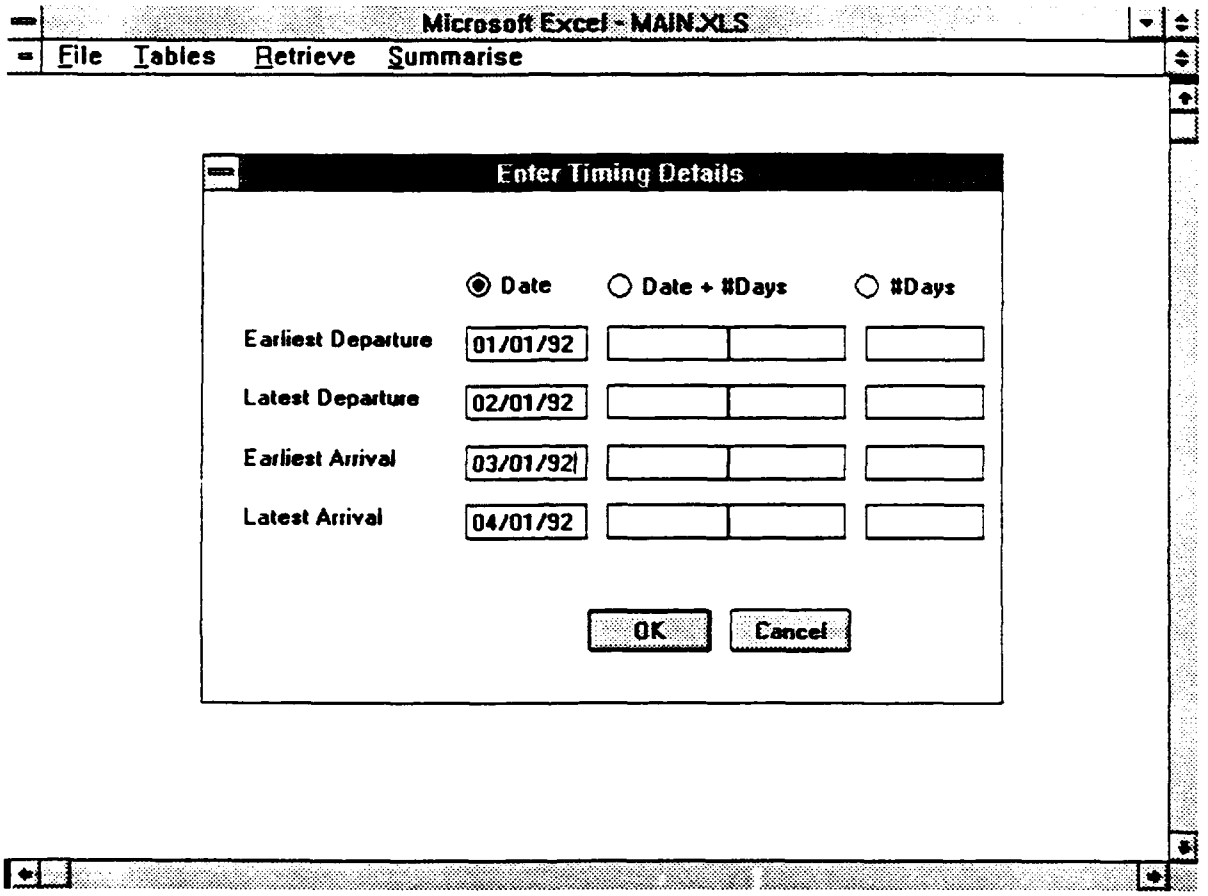


Figure 6. Entry of timing information in the STMT

Once the staff tables have been created they may be retrieved so the user can view a wh table or just selected information.

Figure 7 shows the menu option for initiating information retrieval. All types of staff tabl retrieved either by unit name, element or unit type.

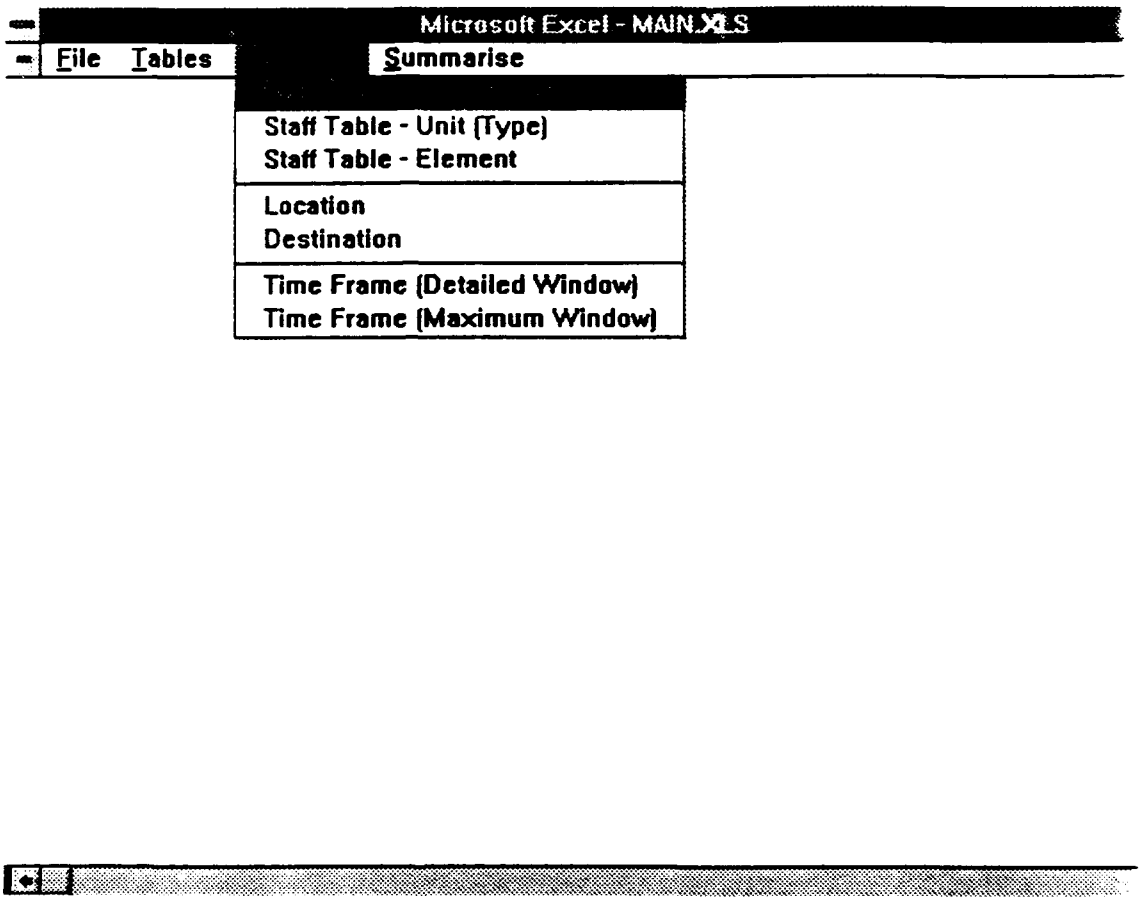


Figure 7. Retrieval menu options in the STMT

Instead of retrieving the whole staff table, the location, destination and timeframe m retrieved for any element or unit.

Summaries of the staff tables are produced either from sorted ORBAT elements or by selecting units according to one or more criteria.

Figure 8 shows the sort function in operation. Sort allows elements which constitute the ORBAT to be ordered by either location, location and destination, location destination and timeframe or by service. A set of elements may then be chosen for the production of a summary as shown in Figure 9.

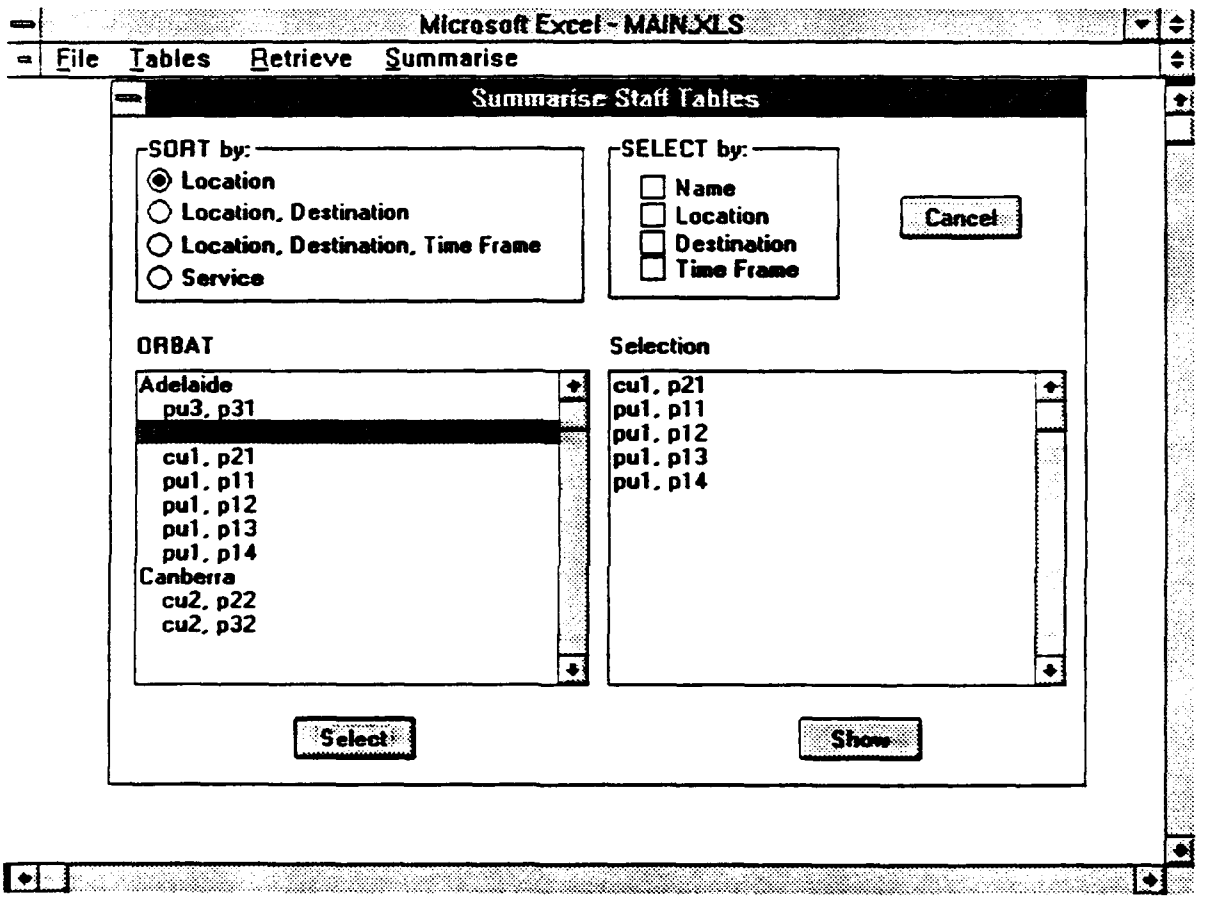


Figure 8. Sort and selection criteria for summarising staff tables

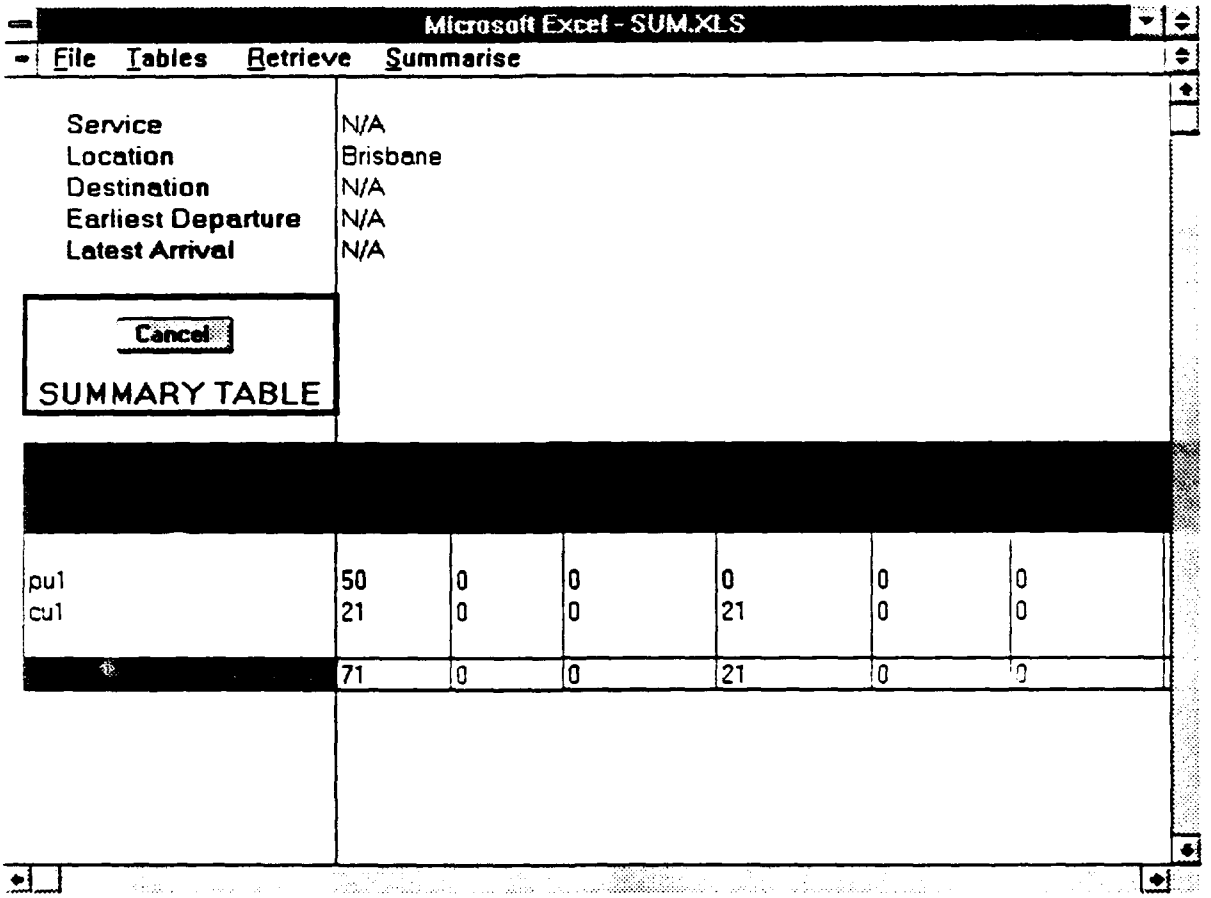


Figure 9. The representation of summary information in the STMT

4.3 The Planning Process Software

The PPS is modelled on the planning process described in Section 3. It supports the user in solving various parts of the planning problem and does not force the user into a single method for solving the problem, instead it provides multiple methods. The PPS is a tool which can be used for planning actual operations, exercises and contingencies.

There are four main components to the PPS: File, Planning, Unknowns, and Display. File performs the usual opening, closing, saving, and printing of files. Planning is the main component and will be discussed in detail. Unknowns keeps track of information which needs to be sought by the user. Display looks at displaying reference material eg transport assets, facilities and items.

In the PPS, planning can be categorised as:

(i) Knowledge of the operational concept of operations;

(ii) Sorting staff table information;

(iii) Defining upfront constraints and suitabilities;

(v) Determining availability;

(vi) Determining limitations;

(vii) Plan development;

(viii) Report generation.

Figure 10 shows the menu under the planning option.

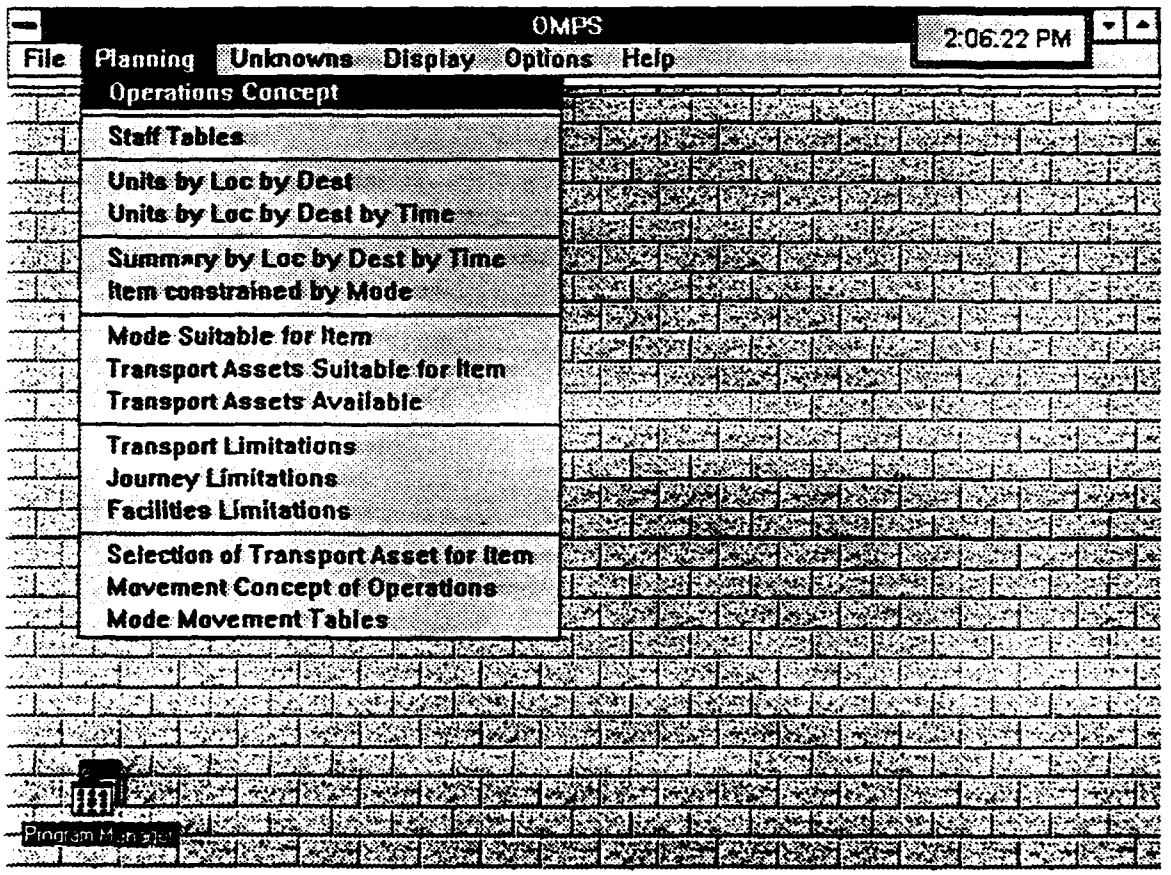


Figure 10. Planning options within the PPS

4.3.1 Concept of operations

Movement planning to support an operation is initiated by the arrival of the Concept of Operations. From the concept of operations the movement planner is able to determine what units or unit types are required, to where and by when. The concept of operations is normally a plain English document with an attached ORBAT which may be in tabular form.

The concept of operations in the PPS is in a tabular form and states the unit, element, phase, destination and any timing information that may be known.

4.3.2 *Staff table information*

Staff table information is taken from the STMT database and can be displayed as either straightforward staff table data by unit with location, staff table data by unit with location and destination, staff table data by unit with location, destination and time, or staff table data by location destination and time where unit contributions to the summary may be displayed.

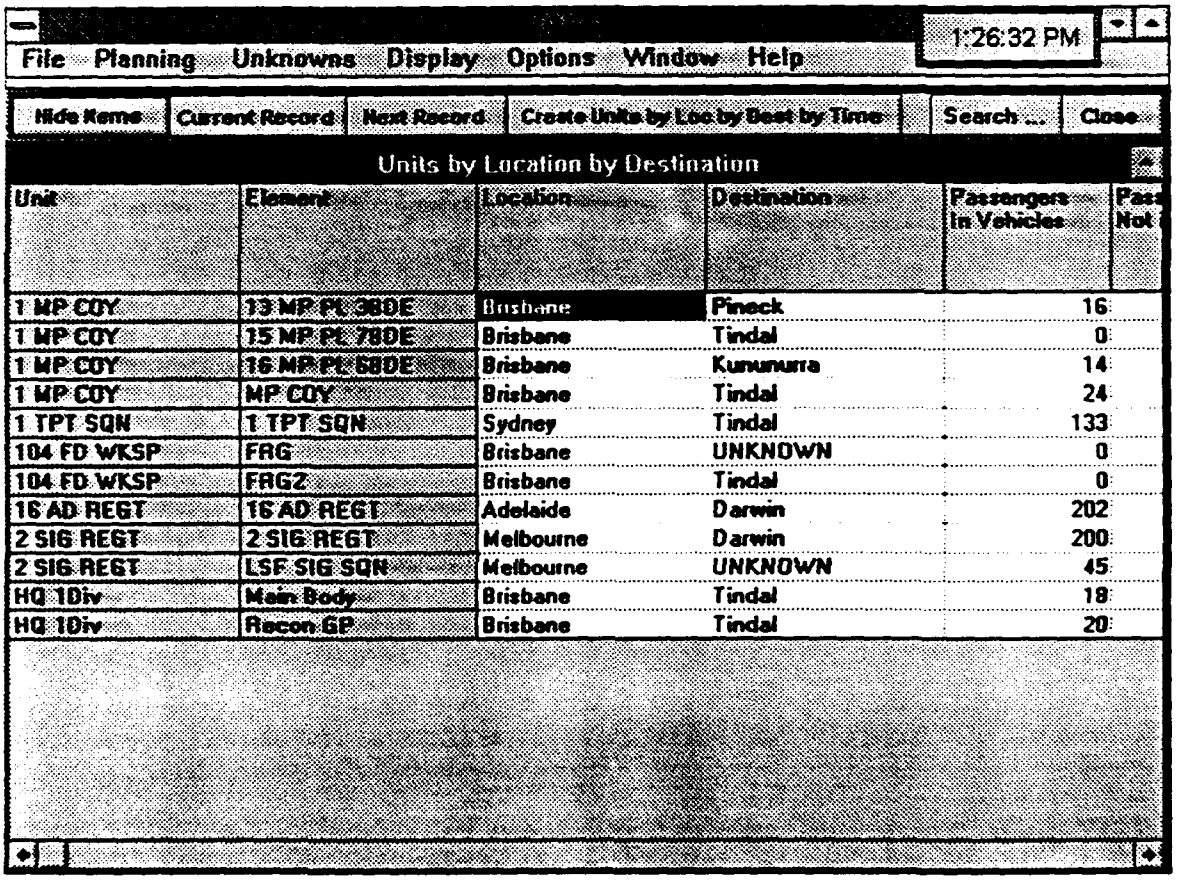


Figure 11. Staff table information by unit by location by destination

Displaying staff table data for multiple units is shown in Figure 11. Key information such as unit, element, location and destination are permanently displayed. Item information can be toggled on and off as required and viewing all items is achieved by scrolling horizontally.

Instead of scrolling horizontally to view the staff table item information, the user can highlight a particular unit and click on the Current Record button. This displays the staff table information for the highlighted unit in a vertical table with only those items being moved for the unit displayed (see Figure 12). Using this technique the user can quickly view the staff table information relating to a single unit.

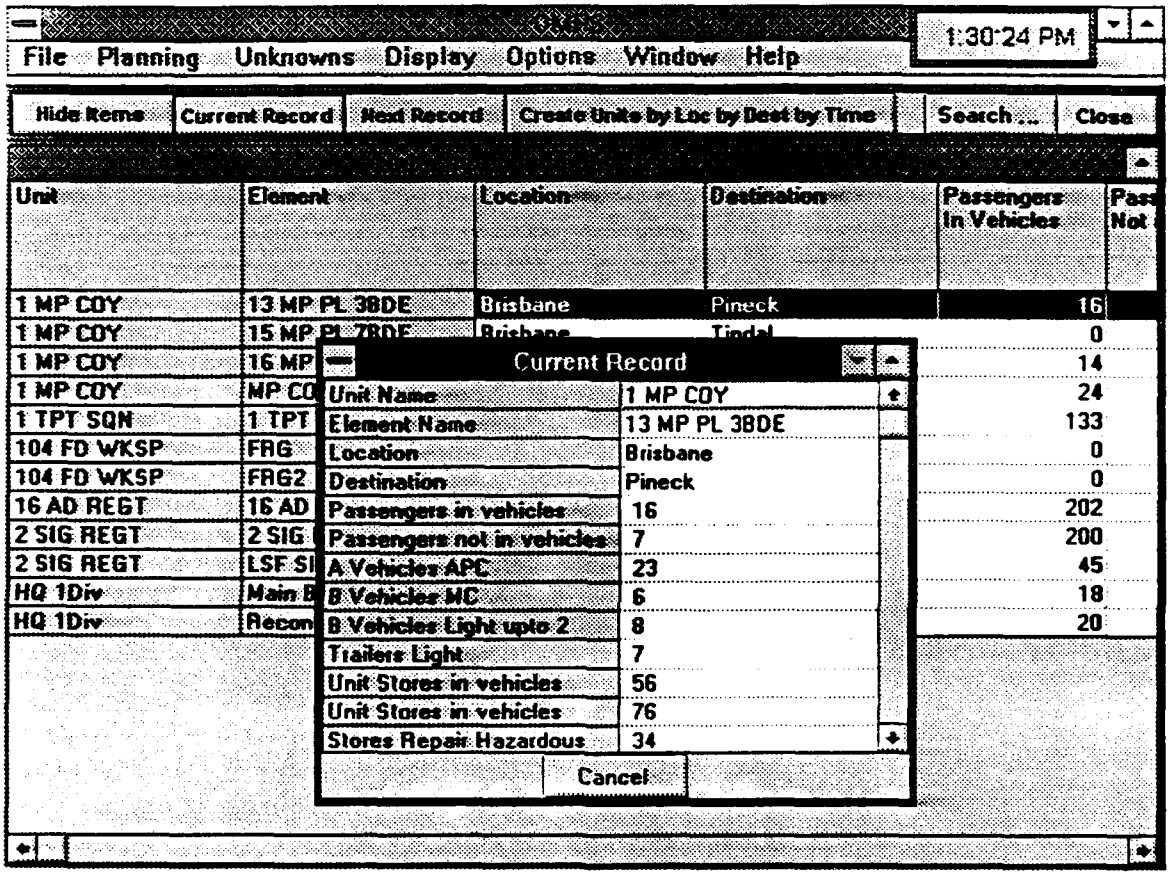


Figure 12. Staff table Information viewed by chosen record

4.3.3 *Define constraints and suitabilities*

Application of upfront constraints is supported by a database of existing upfront constraints. Selection of upfront constraints is achieved by simply highlighting the relevant constraint and clicking on the move button (see Figure 13). This transfers the constraint from either the constraints for the current operation (Current Selected Constraints) to the constraint database (Other Existing Constraints) or vice versa.

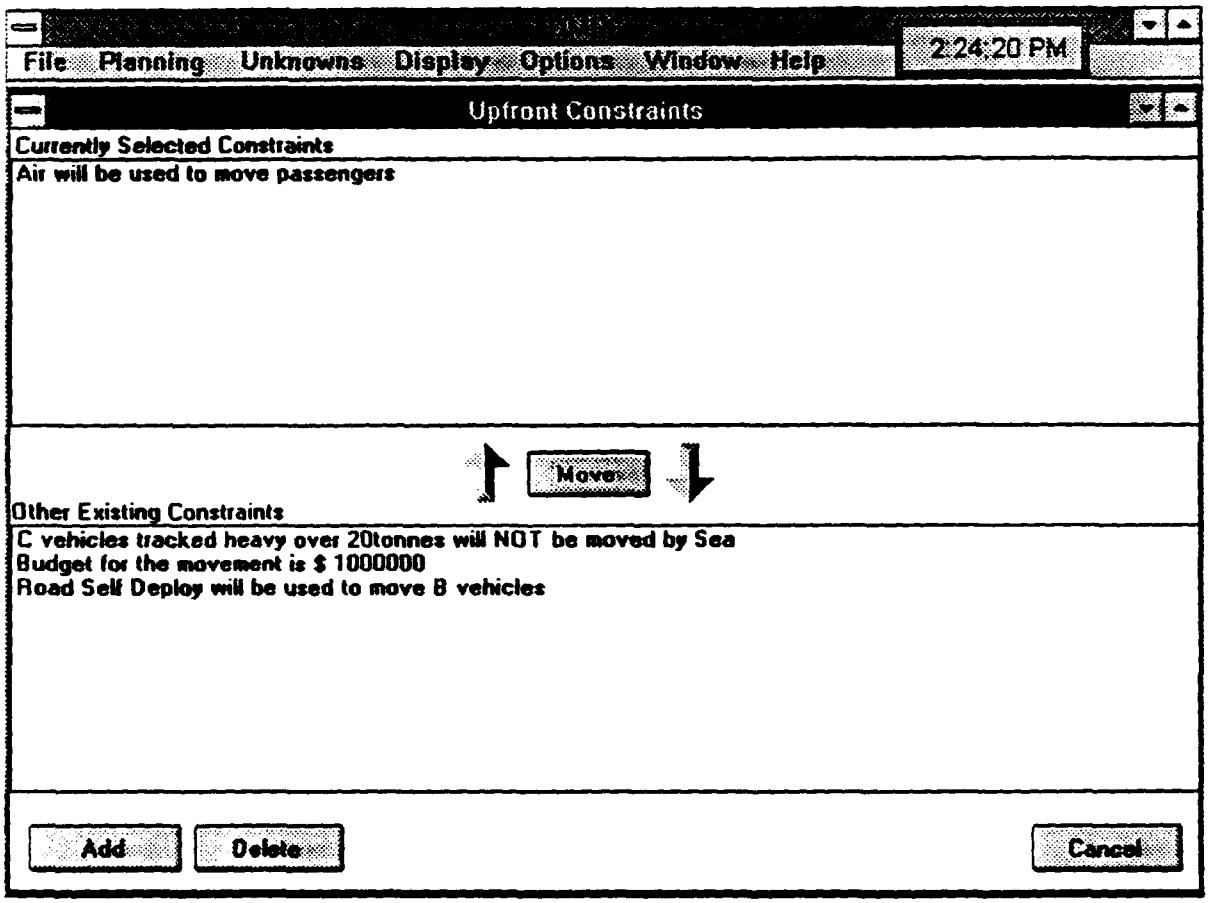


Figure 13. Selecting upfront constraints

Upfront constraints are defined in plain English. Figure 14 shows the constraint definition interface. A constraint may be defined in terms of either mode, item or cost. For example, If the Mode *Air* is selected, and the Item Category is *Passengers* the upfront constraint *Air will be used to move Passengers* is produced and can be added to the upfront constraint database.

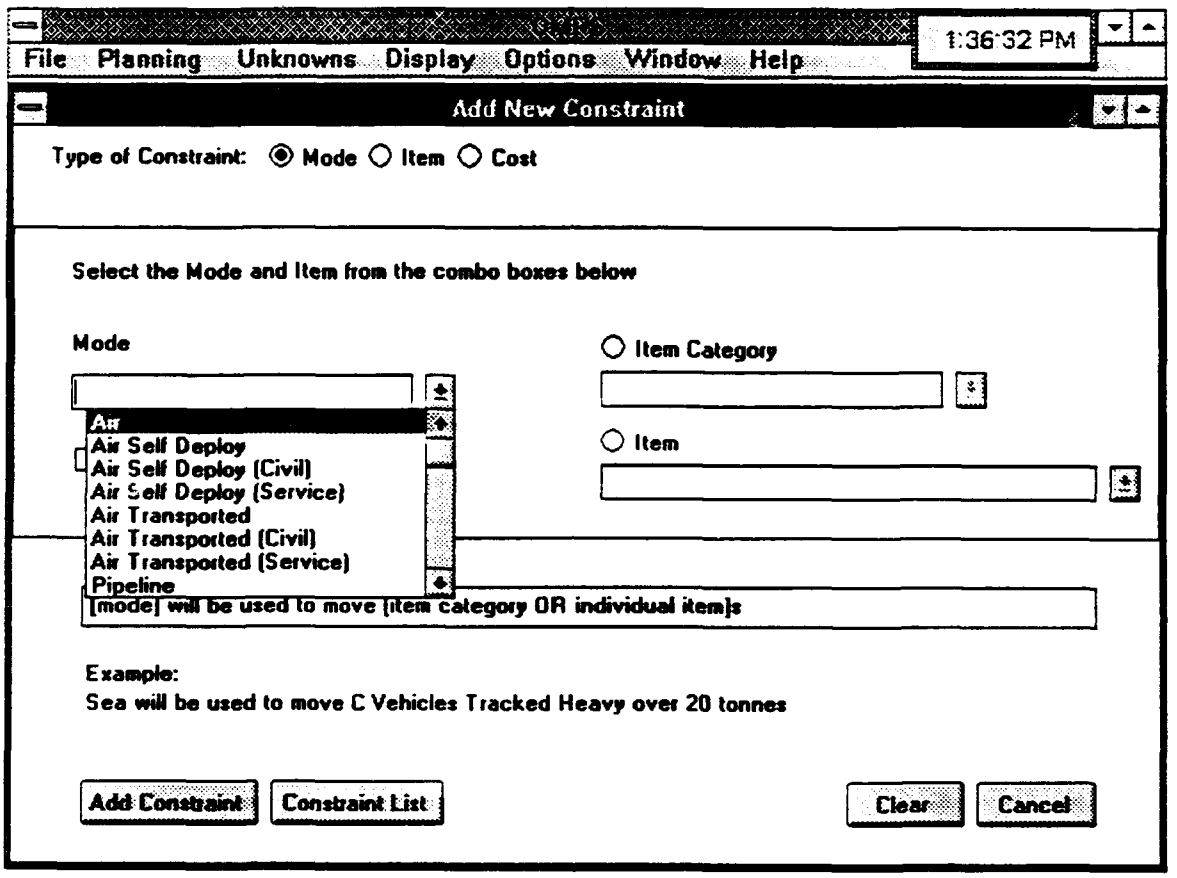


Figure 14. Generating upfront constraints

Suitability is a complex concept which can apply to modes, transports asset types or individual transport assets for an item. The PPS maintains a database of suitabilities which are edited by the user according to the operation being performed.

The PPS supports the user in defining suitability over the range:

Upfront Constraint
Most Suitable
More Suitable
Average Suitable
Less Suitable
Least Suitable
Not Suitable
Not Constraint

Where upfront constraints are present they are carried through the PPS from their definition. It should be noted that the inverse of an Upfront Constraint is a Not Constraint. A Not Constraint is a user defined upfront constraint that includes the word NOT.

Suitability may be defined in terms of mode for item, item for mode, transport asset type for item and item for transport asset type. Figure 15 shows suitability definition of a mode for an item. Suitability displayed may be toggled on and off so that a different category or categories can be seen.

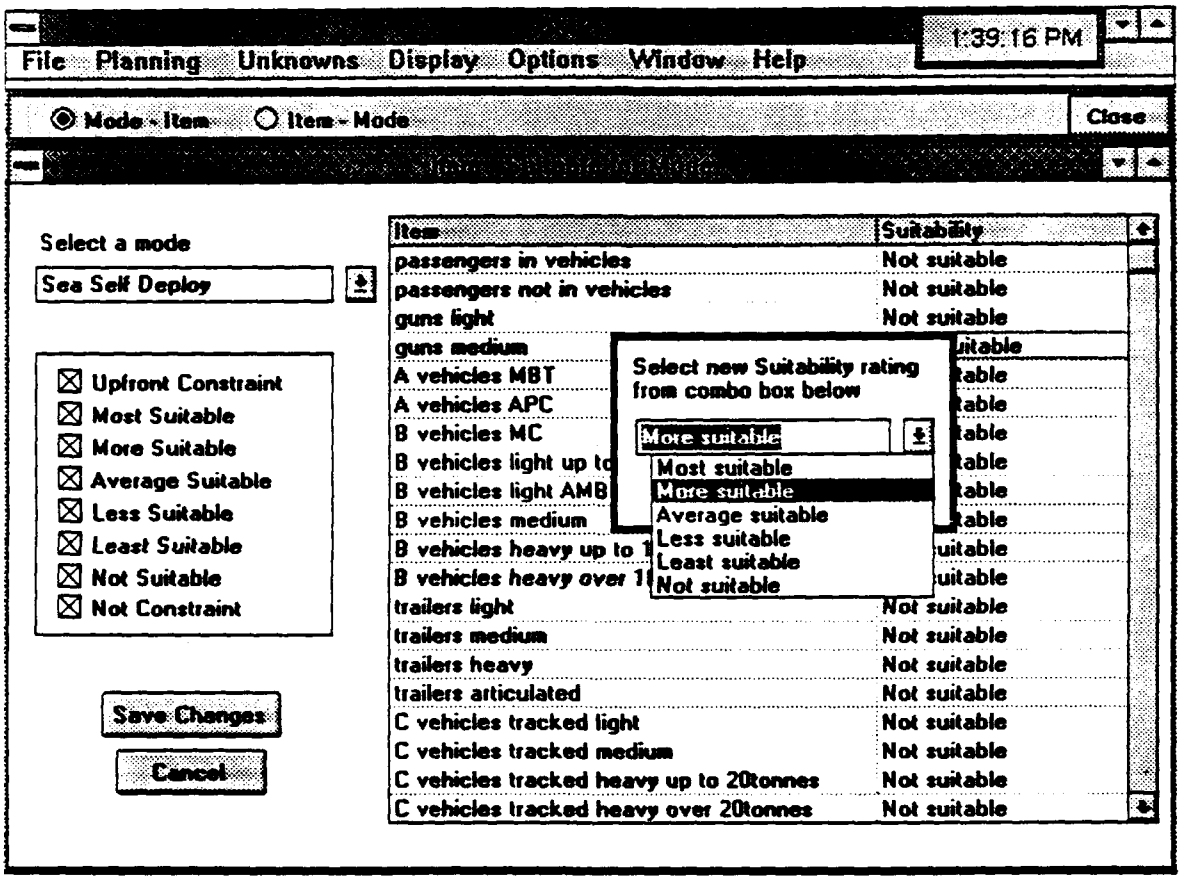


Figure 15. Defining suitability in the PPS

4.3.4 Determine availability

Transport asset availability can be actual availability or assumed/required availability. The PPS maintains a list of all transport assets known or required to be available. The user may also view the transport assets that are available and suitable to move an item.

Currently the user interface is designed to allow the user to enter transport assets into a database. The database holds a number of attributes about the transport asset. Attributes recorded vary according to the mode of the transport asset. Where possible transport asset configurations and standard loads are recorded. Bit map images of the transport assets may also be required. Transport assets that may be entered include: aircraft, rail wagons, trucks, trailers, ships and pallets.

Figure 16 illustrates the details that may be recorded for a transport asset.

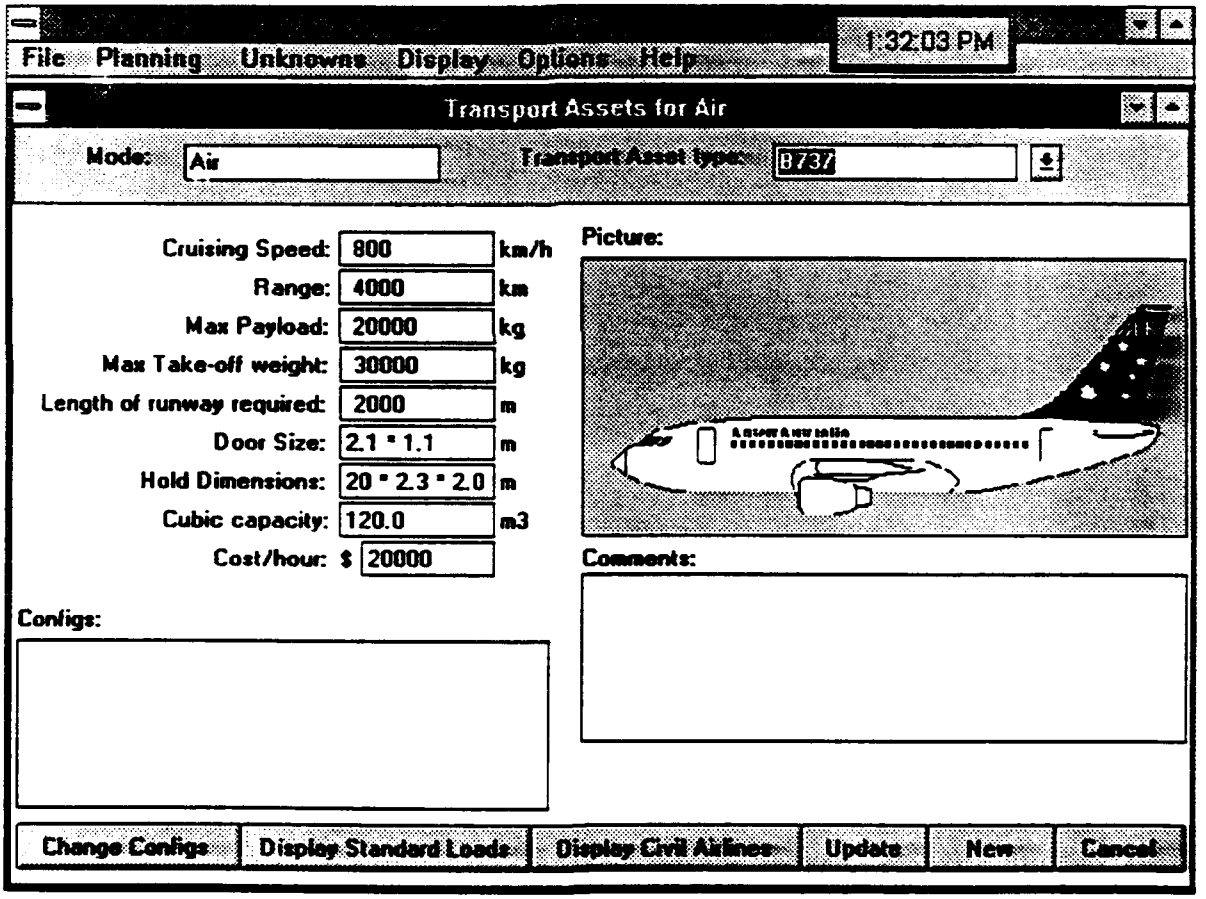


Figure 16. Air transport asset characteristics

4.3.5 Determine limitations

Limitations can be transport, journey or facilities limitations.

Transport limitations record whether an item can be moved by a transport asset. Usually the answer is yes or no. Associated with the answer is a text field which allows the user to record

what the limitation is and whether there are any exceptions or special cases, such as remove the wheels and turn through 90 degrees on entering the transport asset.

A journey may be sub-divided into its routes, stages and trips. A journey consists of one or more routes, each of which is performed by a single mode of transport. A route may be subdivided into stages, being a movement from a location to a destination. If actual time is added to a stage for a transport asset, then it becomes a trip.

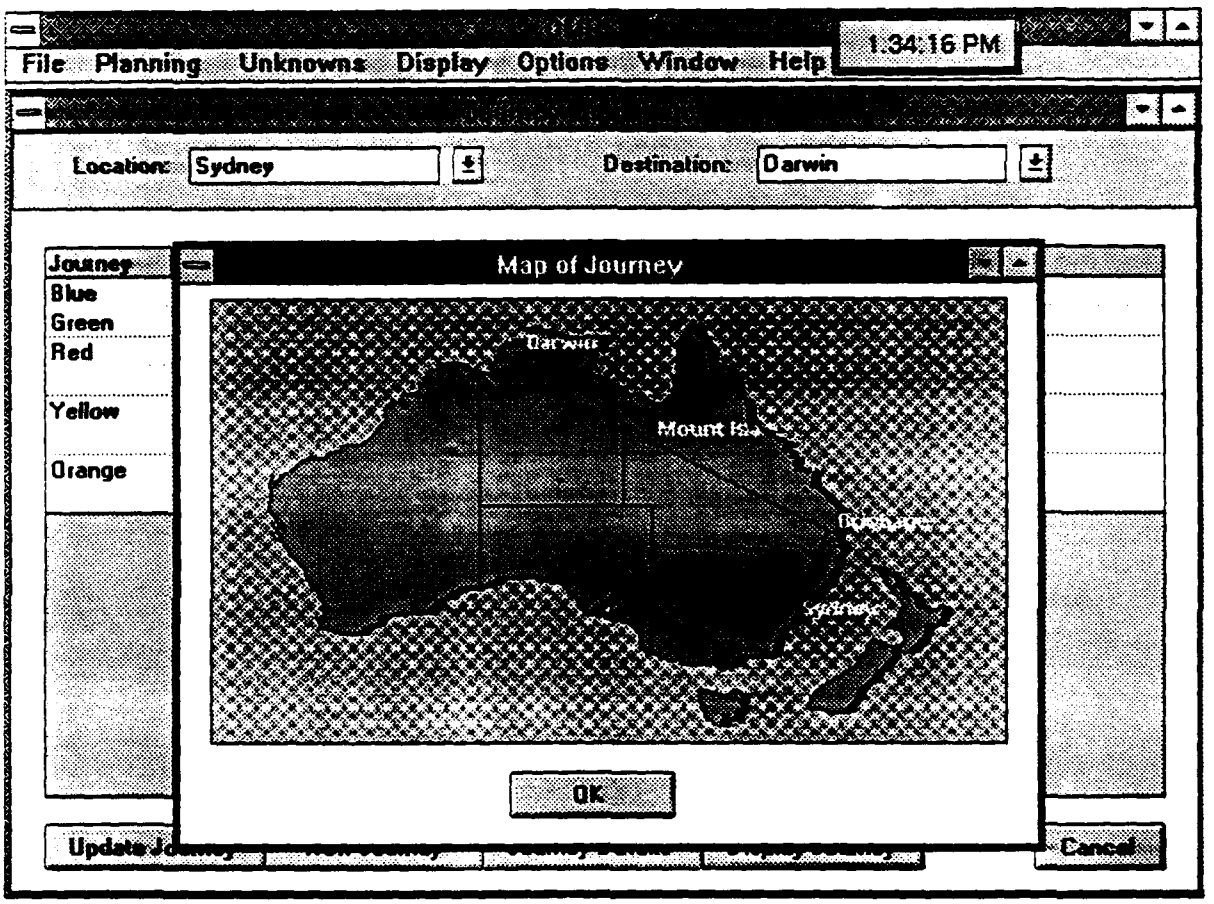


Figure 17. Journey specifications in the PPS

The PPS permits the definition and storage of journeys, routes and stages (see Figure 17). This allows the user to retrieve all possible journeys from a location to a destination. For each route the stages are listed with the length of each stage. It is possible to display some journeys against a map background.

Facilities limitations requires support from a geographic information system. The PPS software has fields for the data that are required in order for the user to assess if there are any facilities limitations which veto or restrict the use of a transport asset or the handling of an item. For all modes the user should address:

(i) Terminal reception capacity;

(ii) Terminal unloading/discharge capacity;

(iii) Terminal clearance capacity;

(iv) Terminal operating considerations;

(v) Mode operating considerations.

Where rail is applicable the user should also look at line carrying capacity, and for road transport, road capacity.

In the short to medium term there will be no ADF geographic information system to support the DMCA's requirement. However, all the user really needs to know is can a transport asset arrive at a facility, and if so, can the items be unloaded and transported away. To satisfy this problem, OMPS provides a table stating whether or not a transport asset or item can use the facility, with a comments area for exceptions.

Figure 18 illustrates the information requirements for air mode operating considerations.

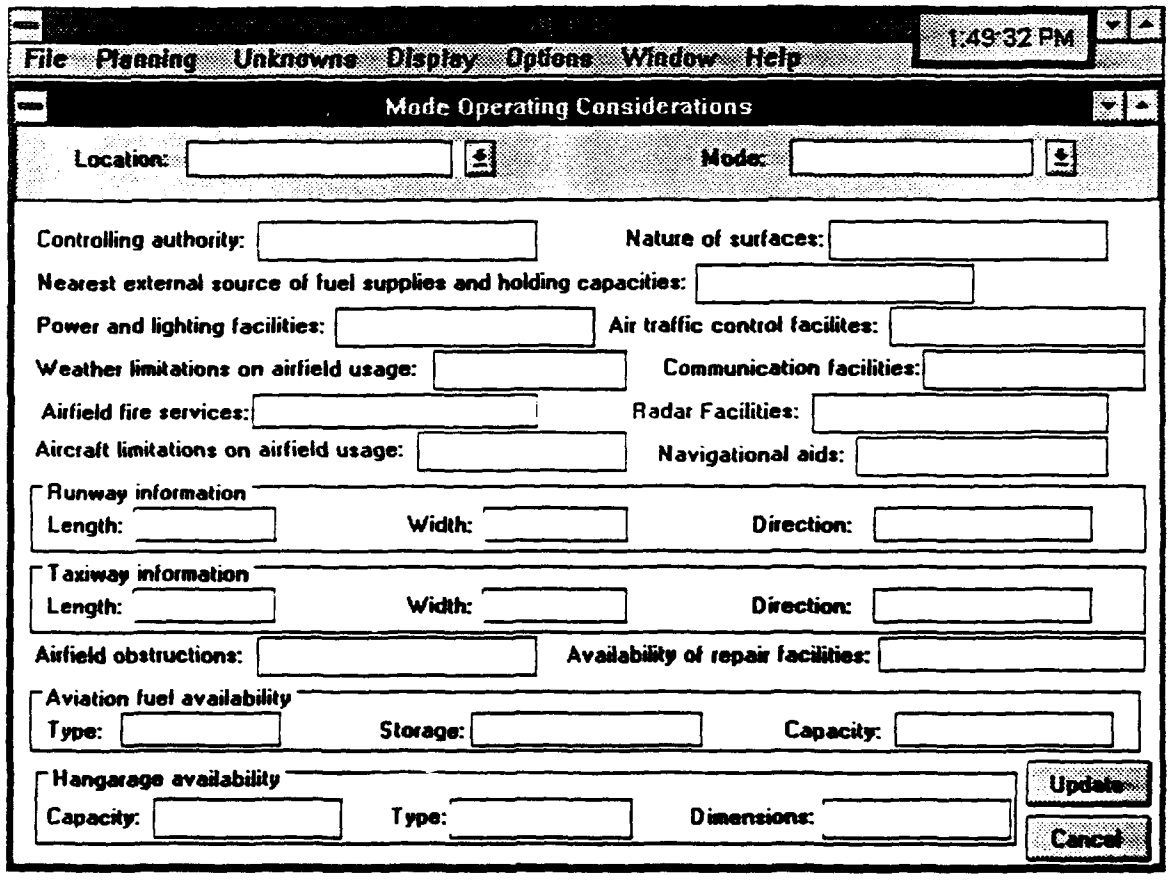


Figure 18. An *example of facilities limitations - air operating considerations*

4.3.6 Develop plan

Plan development in the PPS pulls together all the information previously defined, entered or retrieved and supports the user in several ways.

Figure 19 shows the main planning screen. There are several planning modes: Plan Assessment, Plan Analysis and Rules of Thumb. Overall planning information is also displayed on this screen

such as actual cost, cost as a percentage of budget, the percentage of items moved and transport capacity used.

Rules of Thumb capture procedures which are good things to try in order to reduce the amount of planning work. The PPS software supports automatic allocation of:

(i) Items to transport assets for standard loads;

(ii) Items with only one transport asset;

(iii) Transport assets with only one item.

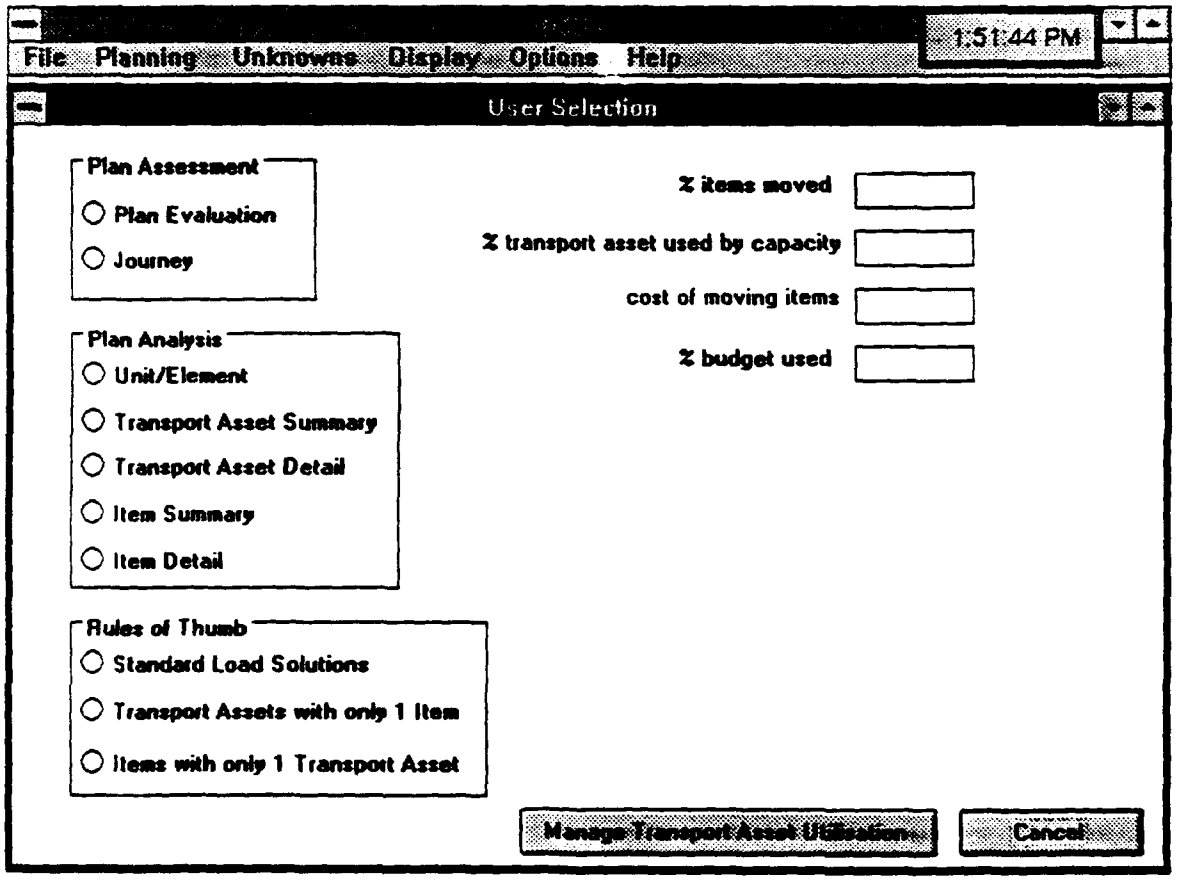


Figure 19. Plan development options in the PPS

Plan Assessment provides a means for the planner to quickly assess the state of the plan in terms of what has been achieved and what is outstanding. If work is outstanding then the planner may assess what needs to be done in terms of mode, item or journeys.

Figure 20 shows the Plan Evaluation by Item screen. This summarises the modes that can, and are being, used to transport a particular item, in this case passengers not in vehicles. The suitability of the mode is shown. Below the mode assessment is a table representing transport assets, within the highlighted mode, which are suitable. The user may also view transport assets available. Displaying transport assets suitable allows the user to assess which transport assets they would like to be made available. Displaying transport assets available allows the user to assess how transport assets are actually being used.

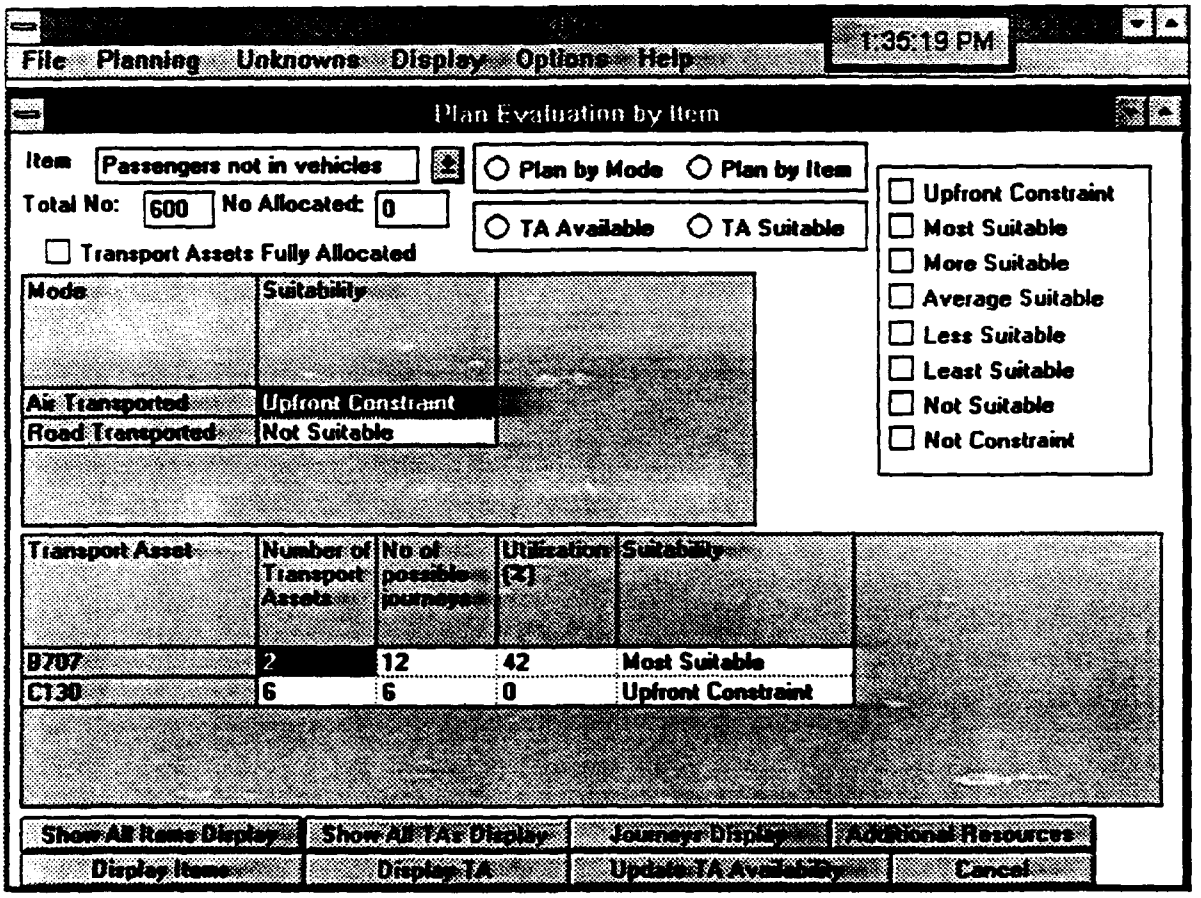


Figure 20. Plan evaluation by item

Plan Analysis supports the user in allocating either transport assets to items, items to transport assets and units, and their items, to transport assets.

Planning summary information is provided at two levels. Figure 21 shows the lower level of detail. For a particular transport asset, the items that can be moved by that transport asset and the number of trips required are shown. Information is also provided on mode and transport asset suitability. The unit to which the items belong is also shown.

From this point the user may choose to allocate an item to a transport asset, look at the items currently allocated to the transport asset or look at other possible transport asset options. Viewing the items already allocated is important to minimising the number of item types and thus the handling requirements. Viewing the transport asset options allows the user to assess if another transport asset can carry the items in an efficient manner.

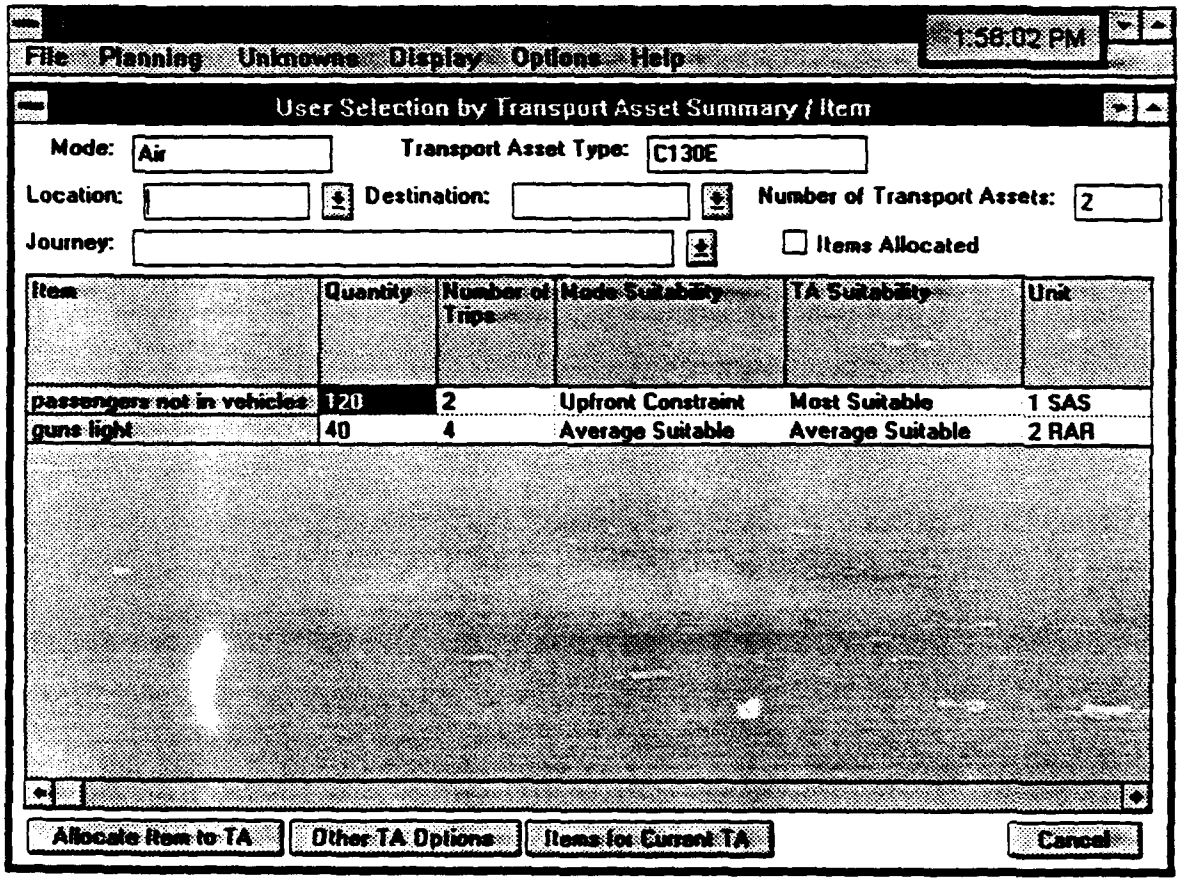


Figure 21. Plan analysis summary by transport asset

Support to plan analysis in detail is shown in Figure 22. The user may view how a specific transport asset type is to move from a location to a destination in a particular timeframe. The journey taken by the transport asset may also be specified. At this level the user is informed of the items that could be moved in terms of quantity, mode and transport asset suitability, the unit name and element.

There are three ways in which the user may proceed: either choose an item to allocate; view the other transport asset options; or view the items currently allocated to the transport asset.

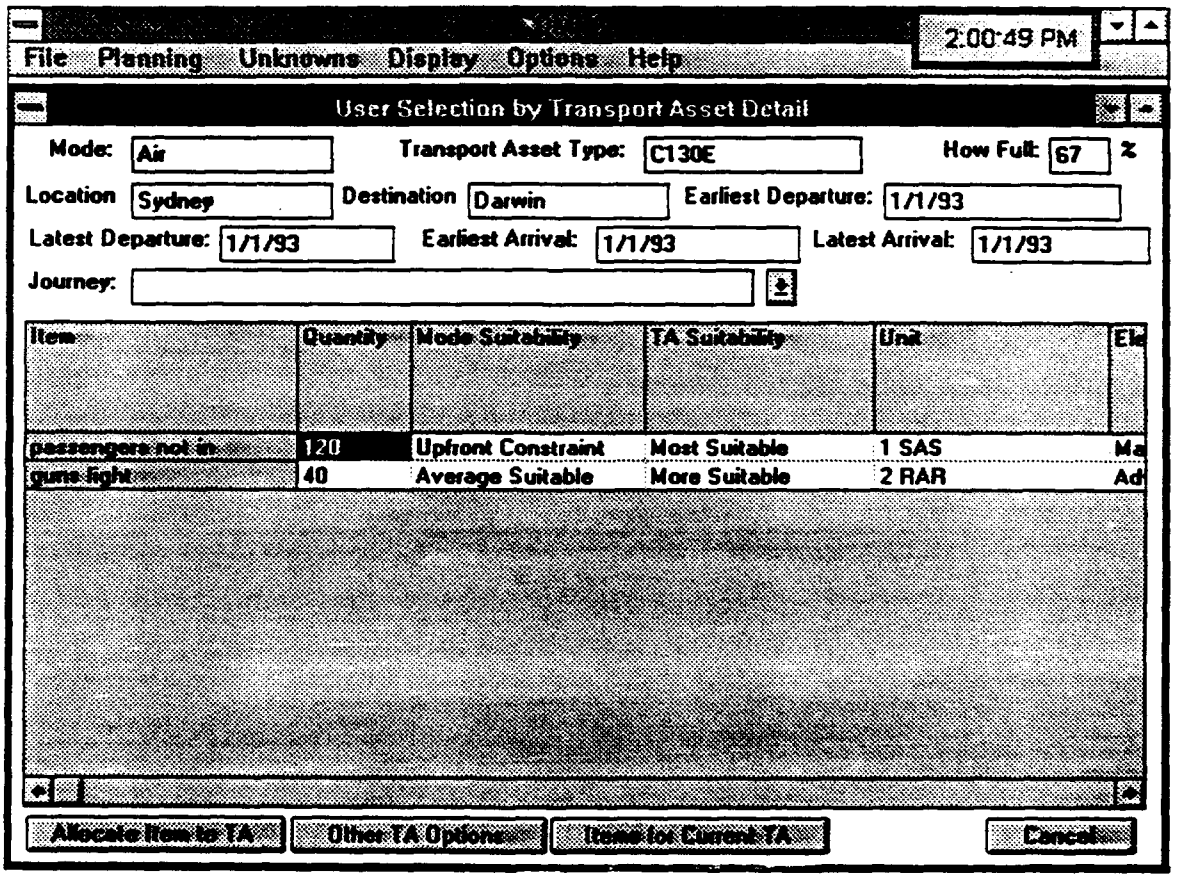


Figure 22. Plan analysis in detail by transport asset

When planning a movement it is often important to ensure that items from a unit are transported together or arrive in the necessary order. Performing plan analysis by Unit/Element supports this kind of decision making. Figure 23 shows the User Selection by Unit Detail screen. For a particular unit or element moving from a location to a destination in a given timeframe, the transport assets moving items belonging to the unit are displayed. The user can click the current items button to view which items are allocated to which transport asset, and the quantity of items allocated. Returning to the User Selection by Unit Detail screen the user can view the items from the unit which are still to be allocated. By highlighting an item and clicking on the Display TA Options the user can view the available transport assets, select one and allocate the item.

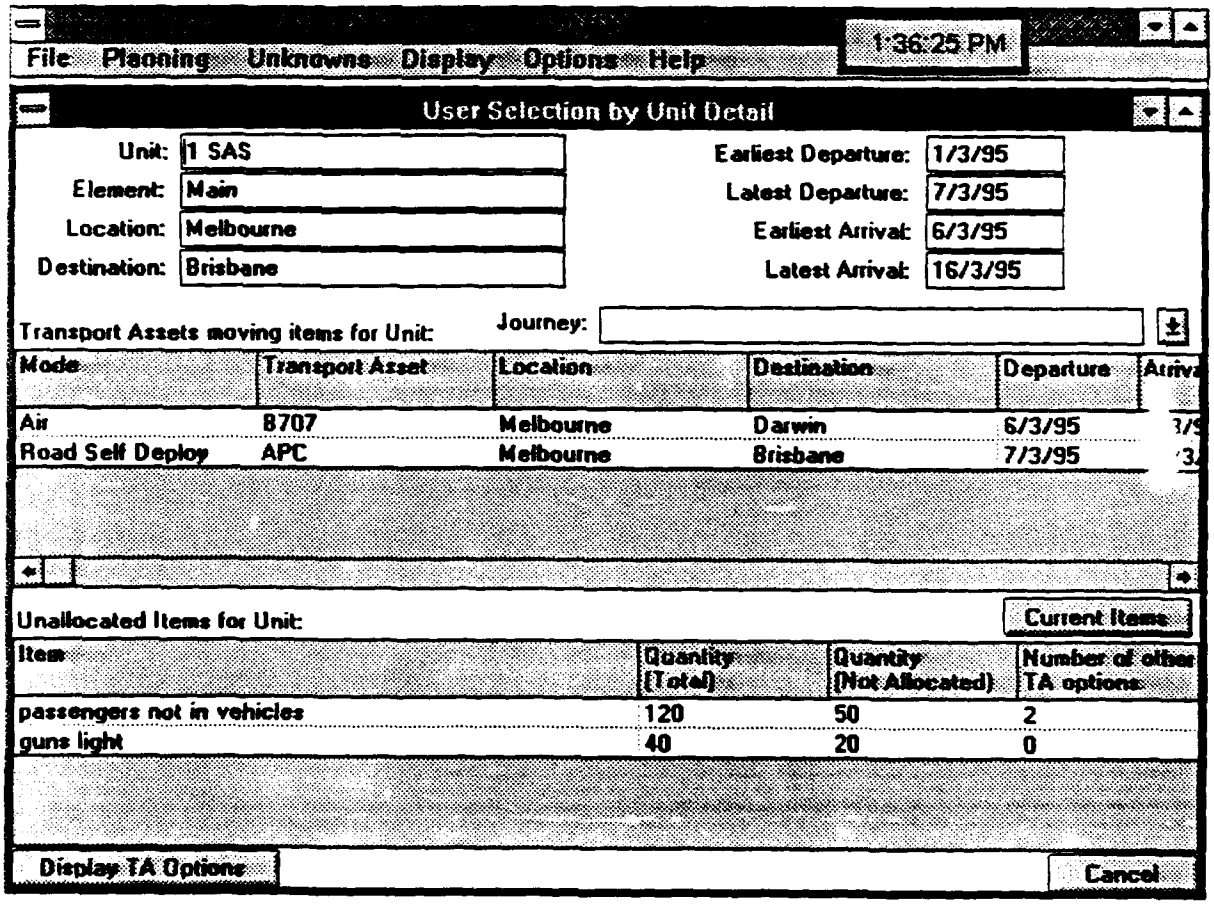


Figure 23. Plan analysis in detail by unit

Performing plan analysis by item permits the user to allocate an item to a transport asset. Figure 24 shows the User Selection by Item Detail screen. For an item, belonging to a unit/element, moving between a location and destination in a given timeframe, the available transport assets and their suitabilities are displayed. Once again, the user can click the Current Items button to view what items are currently allocated to the highlighted transport asset. Highlighting a transport asset and clicking the Allocate Item to Transport Asset leads to the allocation of the item to the transport asset if possible.

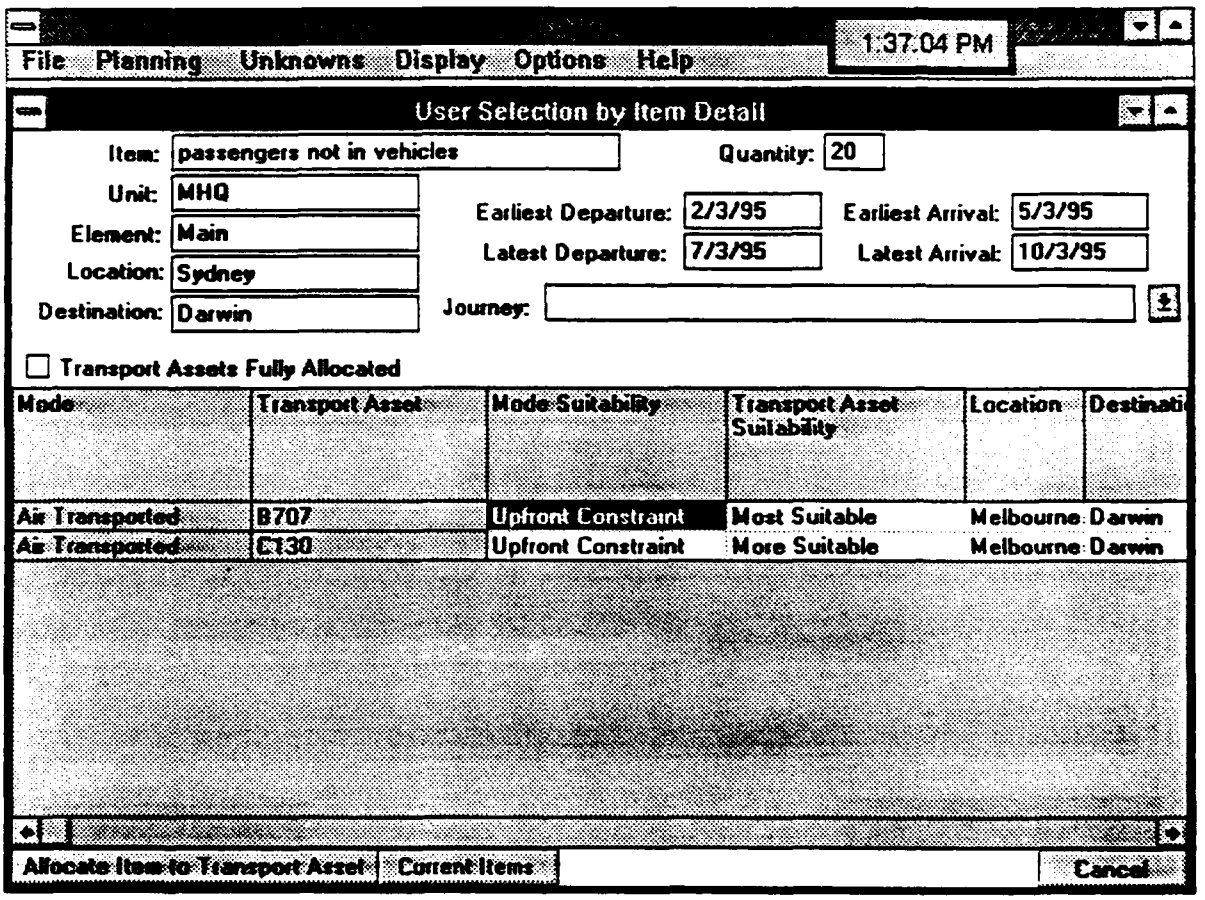


Figure 24. Plan analysis in detail by item

Using the options available under Plan Analysis and Rules of Thumb may lead to allocations being made. Under Plan Analysis the user is very aware of what allocations have been chosen. For Rules of Thumb it is not so obvious. Before any allocations are actually made from either Plan Analysis or Rules of Thumb the proposed allocations are presented to the user (see Figure 25). The user may choose to accept or reject any of the allocations made simply by highlighting the allocation and clicking on the select button.

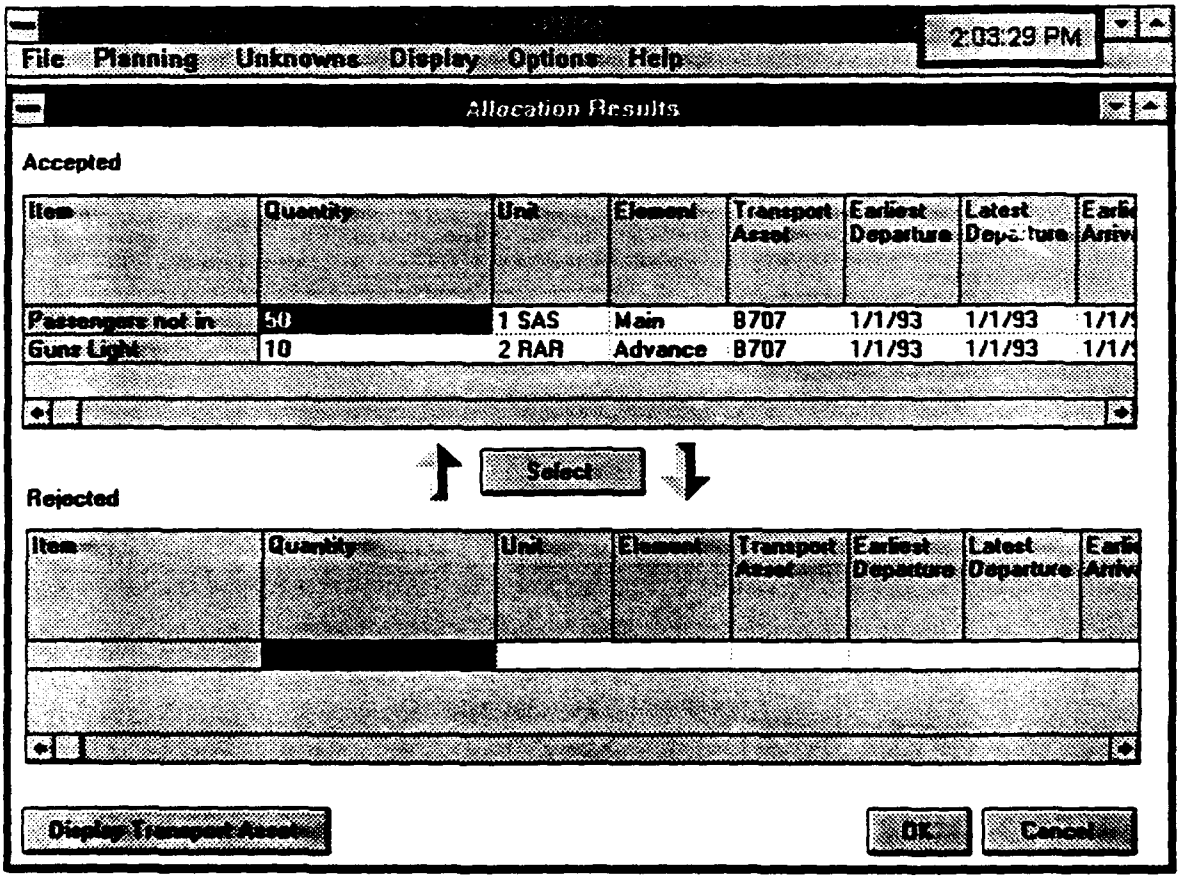


Figure 25. Allocation selection in the PPS

4.3.7 Reports

As the plan evolves the movement concept of operations begins to emerge. Figure 26 shows the OMPS tabular representation of a movements concept. A phase is selected. Associated with the phase is a timeframe and a total cost. Further breakdown of the phase is in terms of mode, transport asset, journey and cost. This allows the user to see at a glance the overall cost of a phase and the major contributors to the total.

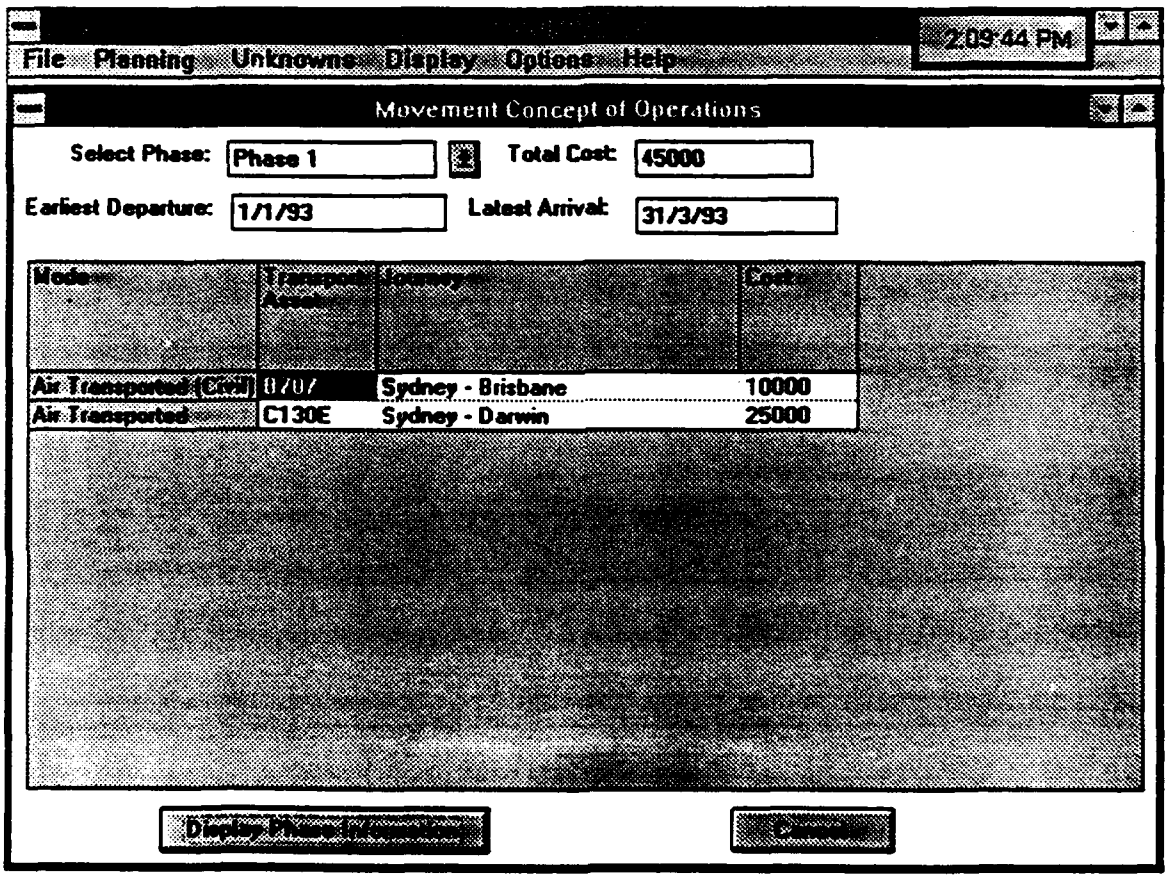


Figure 26. The movement concept of operations

As allocations are made they are entered into the movement table for the operation. Each mode has its own movement table as there are slight variations in the information required. Figure 27 shows the Air Transported Mode Movement Table. Each entry has a serial number and identifies by unit what is to moved, when, where to and by whom.

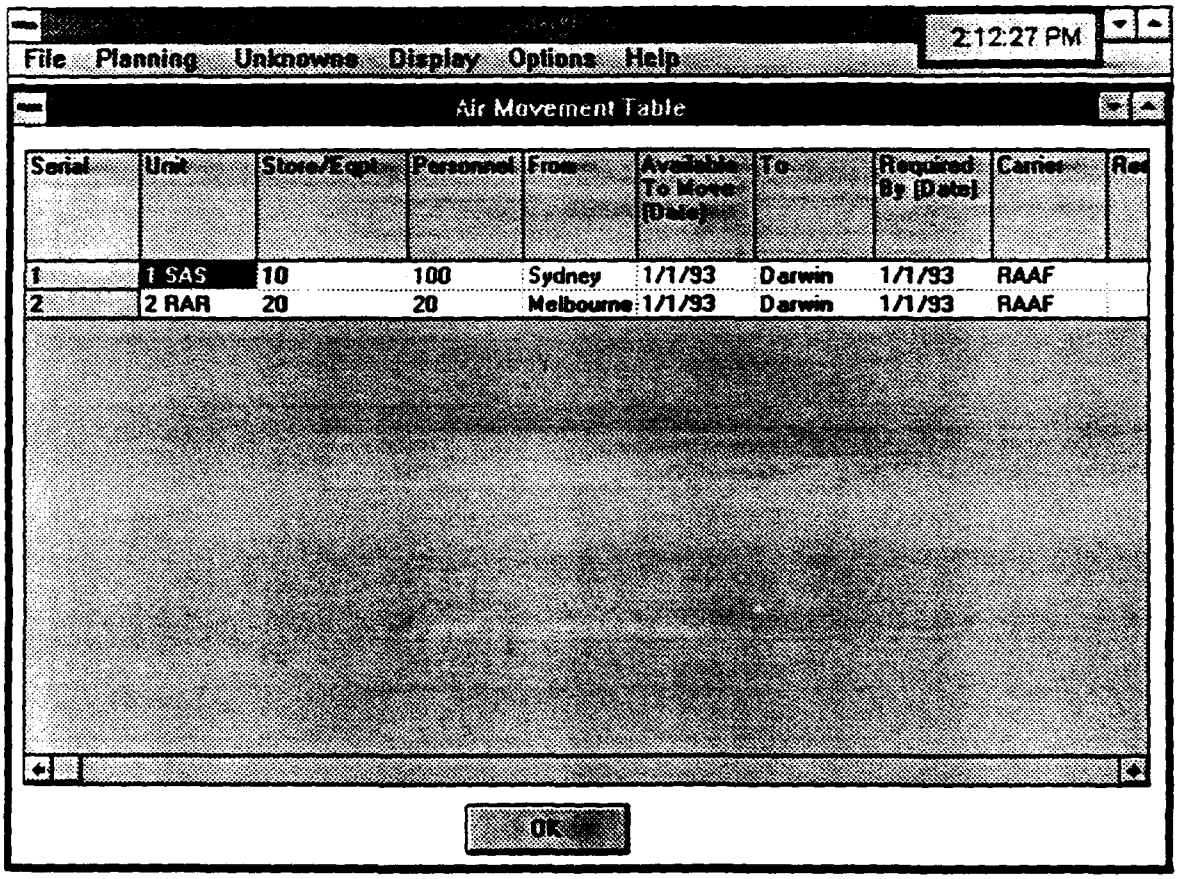


Figure 27. Air transported mode movement table

The movement tables supported are:

(i) Air Self Deploy

(ii) Air Transported

(iii) Rail Freight

(iv) Road Self Deploy

(v) Road Freight

(vi) Sea

5 STATUS AND WAY AHEAD

5.1 Current status

OMPS has been developed on an IBM compatible PC 386 DX computer. This platform was chosen for compatibility with the user's existing equipment, which eased user trialling, and the availability of relatively cheap prototyping software.

The STMT is fully functional and was developed using commercial off the shelf software, Microsoft Excel v 3.0.

The DMCA has trialled the STMT and found the software to integrate well with their work practices. The tool was designed with the understanding that the DMCA may have to deploy to the area of operations in order to plan a redeployment. Under these circumstances staff table information for the deployed units could be loaded on to a portable PC and taken to the area of operations.

For the PPS, effort has been placed on developing the planning framework. Staff table operations, upfront constraints, suitabilities, availabilities and plan development have been implemented but database input routines for transport assets and facilities limitations have yet to be addressed.

The PPS has been developed using Microsoft's Windows v 3.1 and Visual Basic Professional Toolkit v 1.0, Borland's C++ v 3.1, and POET v 1.2, an object oriented database system from BKS. The PPS currently has over 130 screens.

5.2 Way ahead

OMPS has proved the feasibility of applying computer technology to supporting strategic movement planners. Further development of the prototype may now be undertaken by industry. This work will proceed under the ADF Joint Command Support Environment Project.

OMPS was initially designed as a single user tool to be run on a standalone machine. However, as outlined in Section 3.1, DMCA seeks information from, negotiates with, and releases information to, a variety of organisations. Staff table information needs to be supplied in an electronic form. Mode movement tables should be distributed in electronic format. Negotiations with mode operators regarding details of the plan should be performed in a collaborative and shared electronic work environment. Some early work has investigated how to provide such support and collaborative technologies like Groupware appear to hold the key to providing these facilities, although much more needs to be done.

There are several existing information systems within the single service movements domains. For example, Army has:

(i) AUTOQ. A standalone PC-based inventory control system;

(ii) PISCES (Principal Item Stock Control and Entitlement System). A mainframe-based inventory of principal items which are usually higher cost items such as vehicles, communications equipment, weapons, watercraft and construction equipment;

(iii) SCUBA (Stock Control Usage Based Army). A mainframe-based inventory of non-principal items such as boots, field clothing, tentage and consumables.

(iv) PIVUT (Principal Item Visibility and Utilisation Terminal). A PC-based executive information system providing visibility of principal items in and between units, commands and depots, with utilisation and costs.

Anyone of these systems could provide detailed item information to the DMCA. Currently, the DMCA contacts a unit by telephone if detailed item information is required.

A study needs to be undertaken on the relationship of OMPS to single service movement information systems and possibly civil information systems. The study should be mindful of the real need for detailed item, transport asset, or other information by the DMCA . Conclusions drawn from such a study should be mindful of the drawbacks associated with large joint projects such as the Service Manpower, Pay and Personnel

The STMT provides a simple and easy to use interface to an electronic staff table. The use of the STMT by deployable units and operational headquarters, such as Land Command, should be investigated.

OMPS may be used as a starting point for requirements capture in other movement areas. The user interfaces can be isolated from the underlying software and used for the development of storyboards (a series of user interface screen pictures depicting a scenario). A suggested starting point would be the movements area within Land Headquarters.

6 FUTURE RESEARCH

Several future research areas have emerged from the OMPS prototyping work.

It is difficult to tailor detailed features of the software to suit a given user because of the great variance in experience and knowledge of users from different services. The Planning Process Software overcomes this problem by being designed to accommodate all levels. Research needs to address how to customise planning software for different users in a seamless fashion.

OMPS is currently designed for the strategic movements planners. As such it provides a decision support system for a small collocated group. Future research should address how OMPS can be integrated into an organisational decision support system for movements and how such a system can be integrated into command support systems at all levels, up and down the command chain.

There is no doubt that a large amount of information is required by a user when planning decisions are being made. How this information can be managed to avoid information overload and to facilitate decision making needs to be investigated.

Electronic support to strategic movement planners will mean that a database of operational movements plans will be built up. Such a database will capture the solution to several one-off planning situations. These one-off solutions capture an enormous amount of knowledge about strategic movements which should not be lost to future generations. Future research needs to address how the databases of movement plans can be used to capture knowledge, and how this knowledge can be extracted to support the movement planning process.

ACKNOWLEDGEMENTS

The authors would like to thank DGJMOVT and all members of the DMCA for their enthusiasm and cooperation throughout the OMPS project. In particular we would like to express our gratitude to Peter Ferguson, who acted as our domain expert and who had to undergo numerous interrogations in the name of knowledge elicitation sessions.

The support of the ADF Joint Command Support Environment project is also acknowledged. From early on in the OMPS project Col Darryl Poole has shown a strong interest in the planning support environment being prototyped.

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16. Abstract

This paper describes the Operational Movements Planning System (OMPS); a prototype computer system to support the Defence Movements Co-ordination Agency in planning strategic movements. OMPS consists of two elements. The Staff Table Manipulation Tool stores, retrieves, sorts and summarises staff table information. The Planning Process Software supports the definition, storage and application of constraints, and multiple methods for the allocation of items to be moved to transport assets.

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